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MOONLIGHT TABLES.

For some years past this journal has made a practice of publishing, each year, moonlight tables for arc lighting work. These tables have been compiled for us by Mr. H. W. Frund. With the present issue we furnish as a supplement, in the familiar form, Mr. Frund's tables for 1901, his own table and the standard moonlight system appearing side by side.

INTERNATIONAL TRADE.

Some figures are given in our pages this week as to export and import conditions. Not only were the exports for October the largest for any single month in the history of the country, but it is shown that exports exceed the imports during the 10 months of the fiscal year by just about $500,000,000. Barely five years ago the imports exceeded exports by nearly $100,000,000 in the same length of time. For the nine months ending with September, manufactures are $60,000,000 greater than in 1899, gaining chiefly in iron and steel. The figures presented in our pages elsewhere throw some light upon the nature and value of imports and their relation to exports, emphasizing also the fact that trade is in its very nature reciprocal. In some of the jubilations over growing exports, we note the idea advanced that we are going to do the business of the world, supplying every human need. Nothing could be farther from the truth. The growth of our export trade is to be welcomed by all because it increases the volume of the world's wealth and exchanges, and renders life everywhere more easy and comfortable. There are some things which this country will always import, their number and value probably increasing with the larger prosperity enjoyed by this country not merely from its foreign trade, but its internal commerce as well. One thing is certain, namely, that the international trade relationships of the United States are destined to a great increase with benefit to all concerned.

THE LUMINOSITY OF WELSBACH MANTLES.

An interesting paper by Mr. Campbell-Swinton publishes some experiments made to determine whether the illuminating properties of the rare earths used in the Welsbach mantle were the same in cathode rays as in the gas flame. It is pointed out that when a mantle contains a mixture of 99 per cent thoria and 1 per cent ceria, its intrinsic brightness in the gas flame is 11 times greater than when thoria is used alone, and no satisfactory theory seems to have been offered for this remarkable increase in luminosity due to so small an admixture of a second substance. It is also well known that in a Crookes tube, platinum may be melted by the bombardment of cathode rays, and experiments were made to determine whether the admixture of a small percentage of ceria with thoria would show, under cathode ray bombardment, a similar increase in luminosity over unadulterated thoria. The results, which gave a fluctuating and precarious efficiency of about one candle per watt, showed only a small and relatively trivial advantage in favor of the mixture. Consequently, it would seem that the agitation of the molecules of the rare earths in a highly exhausted space under the bombardment of cathode rays, does not produce the same conditions of activity in the spectrum, or the same luminosity, as when the agitation is communicated by the rapidly vibrating molecules of hydrogen and carbon, or their oxides, at the low pressure of the gas flame. As to whether the difference arises from the manner in which the agitation is communicated, or from the modifying attending conditions of temperature and pressure of the gas, it would seem difficult to say.

The Development of the Incandescent Lamp.

When we consider the widely extended use of the incandescent electric lamp at the present day, it is difficult to realize the great difficulties which attended the early development of so seemingly simple a piece of apparatus. What could be simpler in appearance than a glass bulb with nothing in it but a slender thread of carbon with its extremities brought out to a pair of terminals? And yet a cursory glance over the brief history of this lamp, as given in an article, the first section of which appears elsewhere in this issue, will convince the reader of the immense labor which was necessary in order to arrive at this simple structure; or, to put the idea in another form, of the immense total expense which had to be incurred before such a lamp, lasting, say, 800 hours, could be sold at half a dozen for a dollar. The fact is, however, that the difficulty was never likely to be mastered until it was recognized by a master mind that what was wanted was a filament which would not conduct readily, instead of the *ignis fatuus* of previous explorers; i. e., a filament which would conduct very readily. The high-resistance filament meant a long, slender filament with corresponding difficulty in preparation, setting, handling and transportation, and with corresponding opportunity for flaws, imperfections and irregularities. The more difficult problem in detail, led, however, to the greater simplicity of operation, and hence to commercial success.

The incandescent lamp is, in fact, only an illustration of the very general condition that a commodity is expensive in inverse proportion to the expense and labor which has been laid out in producing and facilitating its production. One might readily suppose that a commodity upon the production of which an immense aggregate amount of human labor had been expended would be an essentially expensive article, but observation ordinarily points to the opposite condition when the commodity is one for which there is a large demand.

Standard Time.

It is stated that, commencing with the first day of the twentieth century, namely, the first of January, 1901, the official standard time for all Spain will be the time of the meridian of Greenwich, and will be counted from midnight as 0 hours to midnight as the twenty-fourth hour, so that 6 p. m. will be called, for example, 18 o'clock. Since Spain resides between longitudinal limits that for rough purposes may be called + 4 degs. and — 10 degs., the maximum discrepancy which will be introduced by the adoption of the Greenwich meridian will not exceed forty minutes between the official standard time and the local mean time at any place, while for the seaport of Valencia, which is nearly on the Greenwich meridian, the new time will be practically identical with the mean local time. Spain, therefore, makes two changes in her official time; one in regard to the standard meridian, and the other in regard to the method of counting. The Italian railroads now employ the twenty-four hour method, which formerly was in general use in Italy, and it has been used for some time on certain Canadian railroads. The advantage of its use is that it not only renders the letters a. m. and p. m. unnecessary, but at the same time thereby reduces the chance of misunderstanding and error.

The tendency for all nations to agree upon a common meridian for the reckoning of their time is fostered by the growth of civilization in general, and by the spread and development of the electric telegraph and telephone in particular. In the primitive condition when civilized races maintained but slow and interrupted communication with each other by horse vehicle or sailing boat, there would not be the least mutual advantage in their maintaining a common time meridian. On the other hand, the more intimate, rapid and general the telegraphic communication between peoples and countries, the greater the necessity and advantage of a common time meridian. It would seem to be only a question of time when all the world shall employ a common meridian, and moreover when all countries shall employ the simultaneous time of that meridian for the recording of all important physical phenomena. Even at this time the daily report of the United States Weather Bureau is made for the time of 8 a. m. of the 75th meridian, or 1 p. m. of the Greenwich meridian, and 1 p. m. for Greenwich time is a recognized international daily epoch for all the weather bureaux of the world, as an instant of common reference in the weather history of our planet.

Street Electric Lighting in England.

Elsewhere in this issue we present an article from the pen of Mr. F. H. Minshall, electrical engineer of the borough of Croydon, England, which forms an excellent contribution to the meagre literature of an important subject. As will be seen, both the technical and economic aspects of the questions presented are treated, and figures and analyses included which are of much interest to American engineers, especially for comparative purposes. A reading of Mr. Minshall's paper will probably lead to the conclusion that we have little to learn from England concerning the broader aspects of outdoor electric lighting, though more care appears to be given there to minor though none the less important details. Questions with respect to systems which in this country have received solutions adequate to the present state of the art, are evidently still unsettled ones across the water, as, for example, the question of open vs. enclosed arcs, and of direct current vs. alternating current for arc lighting. Indeed, judging from the discussion last summer at Paris before the joint meeting of the British and American Electrical Engineers, it would appear that in England direct and alternating current are still viewed as constituting antagonistic systems. This point of view is one which prevailed at one time in this country, but which years ago was abandoned after experience had demonstrated the absurdity of a partisan attitude on a question which in every specific instance should receive consideration on its economic aspects alone.

A portion of Mr. Minshall's article which will appeal particularly to American central station men is that in which he gives analyses of cost of arc lighting based on English conditions. In almost every case in this country where a municipal arc lighting contract is to be renewed, unreasonable demands as to price are made, the demands usually being supported by a list of low prices paid by other towns specified—the prices thus adduced being always $80 for a full arc, and some even below $50. Mr. Minshall shows that the station cost of arc light at Croydon is from $108.30 for a 650-watt direct-current arc, using rectifiers, to $80.02 for a 450-watt alternating-current enclosed arc, the prices not including, however, anything for annual cost of the station plant used for arc lighting; and that the cost of the 650-watt alternating current enclosed lights is from $104.50 to $106.48. Confirmation of this range of prices is found in the letter in this issue from our London correspondent, giving the price on a 31-year contract for lighting one of the London districts. In this case the price agreed to by the governing body is $160 (£32) for 750-watt arcs and $110 (£22) for 500-watt arcs.

Though coal is dearer in England than in most portions of this country, the disparity between the cost of producing the arc light there and the prices at which many central stations are supplying municipalities in this country, cannot be explained on that score, for Mr. Minshall bases his cost on current at only 3 cents per kilowatt-hour—an extremely low figure for all but the largest American plants. We believe that the explanation is to be found in the English plants such as that to which the article refers, in the equitable division of station cost made with respect to the prices for public and private

THE ELECTRICAL WORLD AND ENGINEER'S

MOONLIGHT TABLES FOR 1901.

COMPILED BY H. W. FRUND.

These schedules are made up on local mean time. Where standard time is used, and it varies considerably from sun time, the proper deduction or addition must be made.

JANUARY, 1901.

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	5.15 P.M.	1	12.00 M.	1	2.50 A.M.	1	6.20 A.M.
2	5.15 "	2	12.00 "	2	3.50 "	2	6.20 "
3	5.15 "	3	12.00 "	3	No Light.	3	No Light.
4	5.15 "	4	12.00 "	4	"	4	"
5	5.15 "	5	12.00 "	5	"	5	"
6	5.15 "	6	12.00 "	6	5.15 P.M.	6	8.00 P.M.
7	5.20 "	7	12.00 "	7	5.20 "	7	9.00 "
8	5.20 "	8	12.00 "	8	5.20 "	8	10.00 "
9	5.20 "	9	12.00 "	9	5.20 "	9	11.00 "
10	5.20 "	10	12.00 "	10	5.20 "	10	12.00 M.
11	5.20 "	12	12.55 A.M.	11	5.20 "	12	12.55 A.M.
12	5.25 "	13	1.50 "	12	5.25 "	13	1.50 "
13	5.25 "	14	2.45 "	13	5.25 "	14	2.45 "
14	5.25 "	15	3.45 "	14	5.25 "	15	3.45 "
15	5.25 "	16	4.40 "	15	5.25 "	16	4.40 "
16	5.25 "	17	5.35 "	16	5.25 "	17	5.35 "
17	5.30 "	18	6.20 "	17	5.30 "	18	6.20 "
18	5.30 "	19	6.20 "	18	5.30 "	19	6.20 "
19	5.30 "	20	6.20 "	19	5.30 "	20	6.20 "
20	5.30 "	21	6.20 "	20	5.30 "	21	6.20 "
21	5.35 "	22	6.20 "	21	5.35 "	22	6.20 "
22	5.35 "	23	6.20 "	22	5.35 "	23	6.20 "
23	5.35 "	24	6.20 "	23	5.35 "	24	6.20 "
24	5.35 "	25	6.20 "	24	9.10 "	25	6.20 "
25	5.40 "	26	6.20 "	25	10.20 "	26	6.20 "
26	5.40 "	27	6.15 "	26	11.30 "	27	6.15 "
27	5.40 "	27	12.00 M.	27	.....	..	.....
28	12.40 A.M.	28	6.15 A.M.	28	12.40 A.M.	28	6.15 "
28	5.40 P.M.	28	12.00 M.	29	1.45 "	29	6.15 "
29	1.45 A.M.	29	6.15 A.M.	30	2.45 "	30	6.15 "
29	5.45 P.M.	29	12.00 M.	31	3.40 "	31	6.15 "
30	2.45 A.M.	30	6.15 A.M.				
30	5.45 P.M.	30	12.00 M.				
31	5.45 "	31	12.00 M.				

FEBRUARY, 1901.

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	5.45 P.M.	1	12.00 M.	1	No Light.	1	No Light.
2	5.50 "	2	12.00 "	2	"	2	"
3	5.50 "	3	12.00 "	3	"	3	"
4	5.50 "	4	12.00 "	4	5.50 P.M.	4	7.45 P.M.
5	5.50 "	5	12.00 "	5	5.50 "	5	8.45 "
6	5.50 "	6	12.00 "	6	5.50 "	6	9.45 "
7	5.55 "	7	12.00 "	7	5.55 "	7	10.40 "
8	5.55 "	8	12.00 "	8	5.55 "	8	11.40 "
9	5.55 "	10	12.40 A.M.	9	5.55 "	10	12.40 A.M.
10	5.55 "	11	1.30 "	10	5.55 "	11	1.30 "
11	6.00 "	12	2.30 "	11	6.00 "	12	2.30 "
12	6.00 "	13	3.25 "	12	6.00 "	13	3.25 "
13	6.00 "	14	4.15 "	13	6.00 "	14	4.15 "
14	6.00 "	15	5.05 "	14	6.00 "	15	5.05 "
15	6.05 "	16	5.55 "	15	6.05 "	16	5.55 "
16	6.05 "	17	5.55 "	16	6.05 "	17	5.55 "
17	6.05 "	18	5.55 "	17	6.05 "	18	5.55 "
18	6.05 "	19	5.55 "	18	6.05 "	19	5.55 "
19	6.10 "	20	5.50 "	19	6.10 "	20	5.50 "
20	6.10 "	21	5.50 "	20	6.10 "	21	5.50 "
21	6.10 "	22	5.50 "	21	6.10 "	22	5.50 "
22	6.10 "	23	5.45 "	22	9.20 "	23	5.45 "
23	6.15 "	24	5.45 "	23	10.30 "	24	5.45 "
24	6.15 "	25	5.40 "	24	11.40 "	25	5.40 "
25	6.15 "	25	12.00 M.	25	.....	..	....
26	12.40 A.M.	26	5.40 A.M.	26	12.40 A.M.	26	5.40 A.M.
26	6.15 P.M.	26	12.00 M.	27	1.40 "	27	5.40 "
27	1.40 A.M.	27	5.40 A.M.	28	2.25 "	28	5.35 "
27	6.15 P.M.	27	12.00 M.				
28	2.25 A.M.	28	5.35 A.M.				
28	6.20 P.M.	28	12.00 M.				

MARCH, 1901.

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	3.10 A.M.	1	5.35 A.M.	1	3.10 A.M.	1	5.35 A.M.
1	6.20 P.M.	1	12.00 M.	2	3.40 "	2	5.35 "
2	6.20 "	2	12.00 "	3	No Light.	3	No Light.
3	6.20 "	3	12.00 "	4	"	4	"
4	6.25 "	4	12.00 "	5	"	5	"
5	6.25 "	5	12.00 "	6	6.25 P.M.	6	8.30 P.M.
6	6.25 "	6	12.00 "	7	6.25 "	7	9.30 "
7	6.25 "	7	12.00 "	8	6.25 "	8	10.25 "
8	6.25 "	8	12.00 "	9	6.30 "	9	11.20 "
9	6.30 "	9	12.00 "	10	6.30 "	11	12.20 A.M.
10	6.30 "	11	12.20 A.M.	11	6.30 "	12	1.10 "
11	6.30 "	12	1.10 "	12	6.30 "	13	2.00 "
12	6.30 "	13	2.00 "	13	6.35 "	14	2.50 "
13	6.35 "	14	2.50 "	14	6.35 "	15	3.40 "
14	6.35 "	15	3.40 "	15	6.35 "	16	4.20 "
15	6.35 "	16	4.20 "	16	6.35 "	17	5.10 "
16	6.35 "	17	5.10 "	17	6.35 "	18	5.10 "
17	6.35 "	18	5.10 "	18	6.40 "	19	5.10 "
18	6.40 "	19	5.10 "	19	6.40 "	20	5.05 "
19	6.40 "	20	5.05 "	20	6.40 "	21	5.05 "
20	6.40 "	21	5.05 "	21	6.40 "	22	5.05 "
21	6.40 "	22	5.05 "	22	6.40 "	23	5.00 "
22	6.40 "	23	5.00 "	23	6.40 "	24	5.00 "
23	6.45 "	24	5.00 "	24	10.30 "	25	5.00 "
24	6.45 "	25	5.00 "	25	11.30 "	26	5.00 "
25	6.45 "	26	5.00 "	26	.....	..	.....
26	6.45 "	27	4.55 "	27	12.20 A.M.	27	4.55 A.M.
27	6.45 "	27	12.00 M.	28	1.10 "	28	4.55 "
28	1.10 A.M.	28	4.55 A.M.	29	1.45 "	29	4.50 "
28	6.50 P.M.	28	12.00 M.	30	2.20 "	30	4.50 "
29	1.45 A.M.	29	4.50 A.M.	31	2.50 "	31	4.50 "
29	6.50 P.M.	29	12.00 M.				
30	2.20 A.M.	30	4.50 A.M.				
30	6.50 P.M.	30	12.00 M.				
31	6.50 "	31	12.00 "				

APRIL, 1901.

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	6.50 P.M.	1	12.00 M.	1	No Light.	1	No Light.
2	6.55 "	2	12.00 "	2	"	2	"
3	6.55 "	3	12.00 "	3	"	3	"
4	6.55 "	4	12.00 "	4	6.55 P.M.	4	8.20 P.M.
5	6.55 "	5	12.00 "	5	6.55 "	5	9.15 "
6	6.55 "	6	12.00 "	6	6.55 "	6	10.10 "
7	7.00 "	7	12.00 "	7	7.00 "	7	11.10 "
8	7.00 "	8	12.00 "	8	7.00 "	8	12.00 M.
9	7.00 "	10	12.50 A.M.	9	7.00 "	10	12.50 A.M.
10	7.00 "	11	1.35 "	10	7.00 "	11	1.35 "
11	7.00 "	12	2.15 "	11	7.00 "	12	2.15 "
12	7.05 "	13	2.50 "	12	7.05 "	13	2.50 "
13	7.05 "	14	3.30 "	13	7.05 "	14	3.30 "
14	7.05 "	15	4.00 "	14	7.05 "	15	4.00 "
15	7.05 "	16	4.20 "	15	7.05 "	16	4.20 "
16	7.05 "	17	4.20 "	16	7.05 "	17	4.20 "
17	7.10 "	18	4.20 "	17	7.10 "	18	4.20 "
18	7.10 "	19	4.20 "	18	7.10 "	19	4.20 "
19	7.10 "	20	4.20 "	19	7.10 "	20	4.20 "
20	7.10 "	21	4.15 "	20	7.10 "	21	4.15 "
21	7.10 "	22	4.15 "	21	7.10 "	22	4.15 "
22	7.15 "	23	4.15 "	22	10.15 "	23	4.15 "
23	7.15 "	24	4.10 "	23	11.00 "	24	4.10 "
24	7.15 "	25	4.10 "	24	11.45 "	25	4.10 "
25	7.15 "	26	4.10 "	25	.....	..	....
26	7.15 "	26	12.00 M.	26	12.20 A.M.	26	4.10 "
27	12.50 A.M.	27	4.10 A.M.	27	12.50 "	27	4.10 "
27	7.20 P.M.	27	12.00 M.	28	1.20 "	28	4.10 "
28	1.20 A.M.	28	4.10 A.M.	29	1.50 "	29	4.05 "
28	7.20 P.M.	28	12.00 M.	30	2.15 "	30	4.05 "
29	1.50 A.M.	29	4.05 A.M.				
29	7.20 P.M.	29	12.00 M.				
30	7.20 "	30	12.00 "				

MAY, 1901.

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.20 P.M.	1	12.00 M.	1	2.45 A.M.	1	4.05 A.M.
2	7.20 "	2	12.00 "	2	No Light.	2	No Light.
3	7.25 "	3	12.00 "	3	"	3	"
4	7.25 "	4	12.00 "	4	"	4	"
5	7.25 "	5	12.00 "	5	7.25 P.M.	5	9.55 P.M.
6	7.25 "	6	12.00 "	6	7.25 "	6	10.45 "
7	7.25 "	7	12.00 "	7	7.25 "	7	11.30 "
8	7.30 "	9	12.15 A.M.	8	7.30 "	9	12.15 A.M.
9	7.30 "	10	12.50 "	9	7.30 "	10	12.50 "
10	7.30 "	11	1.30 "	10	7.30 "	11	1.30 "
11	7.30 "	12	2.00 "	11	7.30 "	12	2.00 "
12	7.30 "	13	2.40 "	12	7.30 "	13	2.40 "
13	7.35 "	14	3.10 "	13	7.35 "	14	3.10 "
14	7.35 "	15	3.45 "	14	7.35 "	15	3.45 "
15	7.35 "	16	3.45 "	15	7.35 "	16	3.45 "
16	7.35 "	17	3.45 "	16	7.35 "	17	3.45 "
17	7.35 "	18	3.45 "	17	7.35 "	18	3.45 "
18	7.40 "	19	3.45 "	18	7.40 "	19	3.45 "
19	7.40 "	20	3.45 "	19	7.40 "	20	3.45 "
20	7.40 "	21	3.45 "	20	7.40 "	21	3.45 "
21	7.40 "	22	3.40 "	21	9.40 "	22	3.40 "
22	7.40 "	23	3.40 "	22	10.20 "	23	3.40 "
23	7.45 "	24	3.40 "	23	10.50 "	24	3.40 "
24	7.45 "	25	3.40 "	24	11.20 "	25	3.40 "
25	7.45 "	26	3.40 "	25	11.50 "	26	3.40
26	7.45 "	27	3.40 "	26	.....	..	.....
27	7.45 "	27	12.00 M.	27	12.20 A.M.	27	3.40 A.M.
28	12.50 A.M.	28	3.40 A.M.	28	12.50 "	28	3.40 "
28	7.45 P.M.	28	12 M.	20	1.15 "	29	3.35 "
29	1.15 A.M.	29	3.35 A.M.	30	1.50 "	30	3.35 "
29	7.45 P.M.	29	12.00 M.	31	No Light.	31	No Light.
30	7.50 "	30	12.00 "				
31	7.50 "	31	12.00 "				

JUNE, 1901.

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.50 P.M.	1	12.00 M.	1	No Light.	1	No Light.
2	7.50 "	2	12.00 "	2	"	2	"
3	7.50 "	3	12.00 "	3	7.50 P.M.	3	9.30 P.M.
4	7.50 "	4	12.00 "	4	7.50 "	4	10.15 "
5	7.50 "	5	12.00 "	5	7.50 "	5	10.50 "
6	7.55 "	6	12.00 "	6	7.55 "	6	11.30 "
7	7.55 "	7	12.00 "	7	7.55 "	7	12.00 M.
8	7.55 "	9	12.40 A.M.	8	7.55 "	9	12.40 A.M.
9	7.55 "	10	1.10 "	9	7.55 "	10	1.10 "
10	7.55 "	11	1.40 "	10	7.55 "	11	1.40 "
11	7.55 "	12	2.20 "	11	7.55 "	12	2.20 "
12	7.55 "	13	3.00 "	12	7.55 "	13	3.00 "
13	7.55 "	14	3.30 "	13	7.55 "	14	3.30 "
14	7.55 "	15	3.30 "	14	7.55 "	15	3.30 "
15	7.55 "	16	3.30 "	15	7.55 "	16	3.30 "
16	7.55 "	17	3.30 "	16	7.55 "	17	3.30 "
17	8.00 "	18	3.30 "	17	8.00 "	18	3.30 "
18	8.00 "	19	3.30 "	18	8.00 "	19	3.30 "
19	8.00 "	20	3.30 "	19	8.00 "	20	3.30 "
20	8.00 "	21	3.30 "	20	9.20 "	21	3.30 "
21	8.00 "	22	3.30 "	21	9.50 "	22	3.30 "
22	8.00 "	23	3.30 "	22	10.20 "	23	3.30 "
23	8.00 "	24	3.30 "	23	10.50 "	24	3.30 "
24	8.00 "	25	3.30 "	24	11.10 "	25	3.30 "
25	8.00 "	26	3.30 "	25	11.50 "	26	3.30 "
26	8.00 "	27	3.30 "	26	.....	..	.....
27	8.00 "	27	12.00 M.	27	12.20 A.M.	27	3.30 "
28	8.00 "	28	12.00 "	28	1.00 "	28	3.35 "
29	8.00 "	29	12.00 "	29	1.40 "	29	3.35 "
30	8.00 "	30	12.00 "	30	2.20 "	30	3.35 "

JULY, 1901.

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	8.00 P.M.	1	12.00 M.	1	No Light.	1	No Light.
2	8.00 "	2	12.00 "	2	"	2	"
3	8.00 "	3	12.00 "	3	"	3	"
4	8.00 "	4	12.00 "	4	8.00 P.M.	4	10.10 P.M.
5	8.00 "	5	12.00 "	5	8.00 "	5	10.40 "
6	8.00 "	6	12.00 "	6	8.00 "	6	11.15 "
7	8.00 "	7	12.00 "	7	8.00 "	7	11.50 "
8	8.00 "	9	12.20 A.M.	8	8.00 "	9	12.20 A.M.
9	8.00 "	10	1.00 "	9	8.00 "	10	1.00 "
10	8.00 "	11	1.40 "	10	8.00 "	11	1.40 "
11	8.00 "	12	2.30 "	11	8.00 "	12	2.30 "
12	8.00 "	13	3.20 "	12	8.00 "	13	3.20 "
13	8.00 "	14	3.40 "	13	8.00 "	14	3.40 "
14	8.00 "	15	3.40 "	14	8.00 "	15	3.40 "
15	8.00 "	16	3.40 "	15	8.00 "	16	3.40 "
16	8.00 "	17	3.40 "	16	8.00 "	17	3.40 "
17	8.00 "	18	3.45 "	17	8.00 "	18	3.45 "
18	8.00 "	19	3.45 "	18	8.00 "	19	3.45 "
19	8.00 "	20	3.45 "	19	8.00 "	20	3.45 "
20	7.55 "	21	3.45 "	20	7.55 "	21	3.45 "
21	7.55 "	22	3.45 "	21	9.20 "	22	3.45 "
22	7.55 "	23	3.45 "	22	9.50 "	23	3.45 "
23	7.55 "	24	3.50 "	23	10.20 "	24	3.50 "
24	7.55 "	25	3.50 "	24	10.50 "	25	3.50 "
25	7.55 "	26	3.50 "	25	11.35 "	26	3.50 "
26	7.50 "	27	3.50 "	26	.....	..	.....
27	7.50 "	27	12.00 M.	27	12.20 A.M.	27	3.50 "
28	7.50 "	28	12.00 "	28	1.10 "	28	3.50 "
29	7.50 "	29	12.00 "	29	2.10 "	29	3.50 "
30	7.50 "	30	12.00 "	30	No Light.	30	No Light.
31	7.45 "	31	12.00 "	31	"	31	"

AUGUST, 1901.

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.45 P.M.	1	12.00 M.	1	No Light.	1	No Light.
2	7.45 "	2	12.00 "	2	7.45 P.M.	2	9.20 P.M.
3	7.45 "	3	12.00 "	3	7.45 "	3	9.50 "
4	7.45 "	4	12.00 "	4	7.45 "	4	10.20 "
5	7.40 "	5	12.00 "	5	7.40 "	5	11.00 "
6	7.40 "	6	12.00 "	6	7.40 "	6	11.40 "
7	7.40 "	8	12.30 A.M.	7	7.40 "	8	12.30 A.M.
8	7.40 "	9	1.20 "	8	7.40 "	9	1.20 "
9	7.40 "	10	2.15 "	9	7.40 "	10	2.15 "
10	7.35 "	11	3.15 "	10	7.35 "	11	3.15 "
11	7.35 "	12	4.05 "	11	7.35 "	12	4.05 "
12	7.35 "	13	4.05 "	12	7.35 "	13	4.05 "
13	7.30 "	14	4.05 "	13	7.30 "	14	4.05 "
14	7.30 "	15	4.10 "	14	7.30 "	15	4.10 "
15	7.30 "	16	4.10 "	15	7.30 "	16	4.10 "
16	7.30 "	17	4.10 "	16	7.30 "	17	4.10 "
17	7.25 "	18	4.10 "	17	7.25 "	18	4.10 "
18	7.25 "	19	4.10 "	18	7.25 "	19	4.10 "
19	7.25 "	20	4.15 "	19	7.25 "	20	4.15 "
20	7.20 "	21	4.15 "	20	8.50 "	21	4.15 "
21	7.20 "	22	4.15 "	21	9.30 "	22	4.15 "
22	7.20 "	23	4.15 "	22	10.15 "	23	4.15 "
23	7.20 "	24	4.15 "	23	11.00 "	24	4.15 "
24	7.15 "	25	4.20 "	24	12.00 M.	25	4.20 "
25	7.15 "	25	12.00 M.	25	.....	..	....
26	7.15 "	26	12.00 "	26	1.00 A.M.	26	4.20 "
27	7.15 "	27	12.00 "	27	2.00 "	27	4.20 "
28	7.10 "	28	12.00 "	28	No Light.	28	No Light.
29	7.10 "	29	12.00 "	29	"	29	"
30	7.10 "	30	12.00 "	30	"	30	"
31	7.05 "	31	12.00 "	31	7.05 P.M.	31	8.30 P.M.

SEPTEMBER, 1901.

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.05 P.M.	1	12.00 M.	1	7.05 P.M.	1	9.00 P.M.
2	7.05 "	2	12.00 "	2	7.05 "	2	9.40 "
3	7.00 "	3	12.00 "	3	7.00 "	3	10.25 "
4	7.00 "	4	12.00 "	4	7.00 "	4	11.15 "
5	7.00 "	6	12.10 A.M.	5	7.00 "	6	12.10 A.M.
6	6.55 "	7	1.10 "	6	6.55 "	7	1.10 "
7	6.55 "	8	2.10 "	7	6.55 "	8	2.10 "
8	6.55 "	9	3.15 "	8	6.55 "	9	3.15 "
9	6.50 "	10	4.20 "	9	6.50 "	10	4.20 "
10	6.50 "	11	4.35 "	10	6.50 "	11	4.35 "
11	6.50 "	12	4.35 "	11	6.50 "	12	4.35 "
12	6.50 "	13	4.35 "	12	6.50 "	13	4.35 "
13	6.45 "	14	4.35 "	13	6.45 "	14	4.35 "
14	6.45 "	15	4.35 "	14	6.45 "	15	4.35 "
15	6.40 "	16	4.40 "	15	6.40 "	16	4.40 "
16	6.40 "	17	4.40 "	16	6.40 "	17	4.40 "
17	6.40 "	18	4.40 "	17	6.40 "	18	4.40 "
18	6.35 "	19	4.40 "	18	8.10 "	19	4.40 "
19	6.35 "	20	4.40 "	19	9.00 "	20	4.40 "
20	6.35 "	21	4.45 "	20	9.45 "	21	4.45 "
21	6.30 "	22	4.45 "	21	10.40 "	22	4.45 "
22	6.30 "	23	4.45 "	22	11.40 "	23	4.45 "
23	6.30 "	23	12.00 M.	23	.....	..	.....
24	12.40 A.M.	24	4.45 A.M.	24	12.40 A.M.	24	4.45 "
24	6.25 P.M.	24	12.00 M.	25	1.40 "	25	4.50 "
25	6.25 "	25	12.00 "	26	2.50 "	26	4.50 "
26	6.25 "	26	12.00 "	27	No Light.	27	No Light.
27	6.25 "	27	12.00 "	28	"	28	"
28	6.20 "	28	12.00 "	29	"	29	"
29	6.20 "	29	12.00 "	30	6.20 P.M.	30	8.20 P.M.
30	6.20 "	30	12.00 "				

OCTOBER, 1901.

NOVEMBER, 1901.

DECEMBER, 1901.

JULY, 1901.

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	8.00 P.M.	1	12.00 M.	1	No Light.	1	No Light.
2	8.00 "	2	12.00 "	2	"	2	"
3	8.00 "	3	12.00 "	3	"	3	"
4	8.00 "	4	12.00 "	4	8.00 P.M.	4	10.10 P.M.
5	8.00 "	5	12.00 "	5	8.00 "	5	10.40 "
6	8.00 "	6	12.00 "	6	8.00 "	6	11.15 "
7	8.00 "	7	12.00 "	7	8.00 "	7	11.50 "
8	8.00 "	9	12.20 A.M.	8	8.00 "	9	12.20 A.M.
9	8.00 "	10	1.00 "	9	8.00 "	10	1.00 "
10	8.00 "	11	1.40 "	10	8.00 "	11	1.40 "
11	8.00 "	12	2.30 "	11	8.00 "	12	2.30 "
12	8.00 "	13	3.20 "	12	8.00 "	13	3.20 "
13	8.00 "	14	3.40 "	13	8.00 "	14	3.40 "
14	8.00 "	15	3.40 "	14	8.00 "	15	3.40 "
15	8.00 "	16	3.40 "	15	8.00 "	16	3.40 "
16	8.00 "	17	3.40 "	16	8.00 "	17	3.40 "
17	8.00 "	18	3.45 "	17	8.00 "	18	3.45 "
18	8.00 "	19	3.45 "	18	8.00 "	19	3.45 "
19	8.00 "	20	3.45 "	19	8.00 "	20	3.45 "
20	7.[illegible] "	21	3.45 "	20	7.55 "	21	3.45 "
21	7.55 "	22	3.45 "	21	9.20 "	22	3.45 "
22	7.55 "	23	3.45 "	22	9.50 "	23	3.45 "
23	7.55 "	24	3.50 "	23	10.20 "	24	3.50 "
24	7.55 "	25	3.50 "	24	10.50 "	25	3.50 "
25	7.55 "	26	3.50 "	25	11.35 "	26	3.50 "
26	7.50 "	27	3.50 "	26	.....	..	.....
27	7.50 "	27	12.00 M.	27	12.20 A.M.	27	3.50 "
28	7.50 "	28	12.00 "	28	1.10 "	28	3.50 "
29	7.50 "	29	12.00 "	29	2.10 "	29	3.50 "
30	7.50 "	30	12.00 "	30	No Light.	30	No Light.
31	7.45 "	31	12.00 "	31	"	31	"

AUGUST, 1901.

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.45 P.M.	1	12.00 M.	1	No Light.	1	No Light.
2	7.45 "	2	12.00 "	2	7.45 P.M.	2	9.20 P.M.
3	7.45 "	3	12.00 "	3	7.45 "	3	9.50 "
4	7.45 "	4	12.00 "	4	7.45 "	4	10.20 "
5	7.40 "	5	12.00 "	5	7.40 "	5	11.00 "
6	7.40 "	6	12.00 "	6	7.40 "	6	11.40 "
7	7.40 "	8	12.30 A.M.	7	7.40 "	8	12.30 A.M.
8	7.40 "	9	1.20 "	8	7.40 "	9	1.20 "
9	7.40 "	10	2.15 "	9	7.40 "	10	2.15 "
10	7.35 "	11	3.15 "	10	7.35 "	11	3.15 "
11	7.35 "	12	4.05 "	11	7.35 "	12	4.05 "
12	7.35 "	13	4.05 "	12	7.35 "	13	4.05 "
13	7.30 "	14	4.05 "	13	7.30 "	14	4.05 "
14	7.30 "	15	4.10 "	14	7.30 "	15	4.10 "
15	7.30 "	16	4.10 "	15	7.30 "	16	4.10 "
16	7.30 "	17	4.10 "	16	7.30 "	17	4.10 "
17	7.25 "	18	4.10 "	17	7.25 "	18	4.10 "
18	7.25 "	19	4.10 "	18	7.25 "	19	4.10 "
19	7.25 "	20	4.15 "	19	7.25 "	20	4.15 "
20	7.20 "	21	4.15 "	20	8.50 "	21	4.15 "
21	7.20 "	22	4.15 "	21	9.30 "	22	4.15 "
22	7.20 "	23	4.15 "	22	10.15 "	23	4.15 "
23	7.20 "	24	4.15 "	23	11.00 "	24	4.15 "
24	7.15 "	25	4.20 "	24	12.00 M.	25	4.20 "
25	7.15 "	25	12.00 M.	25	.....	..	....
26	7.15 "	26	12.00 "	26	1.00 A.M.	26	4.20 "
27	7.15 "	27	12.00 "	27	2.00 "	27	4.20 "
28	7.10 "	28	12.00 "	28	No Light.	28	No Light.
29	7.10 "	29	12.00 "	29	"	29	"
30	7.10 "	30	12.00 "	30	"	30	"
31	7.05 "	31	12.00 "	31	7.05 P.M.	31	8.30 P.M.

SEPTEMBER, 1901.

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	7.05 P.M.	1	12.00 M.	1	7.05 P.M.	1	9.00 P.M.
2	7.05 "	2	12.00 "	2	7.05 "	2	9.40 "
3	7.00 "	3	12.00 "	3	7.00 "	3	10.25 "
4	7.00 "	4	12.00 "	4	7.00 "	4	11.15 "
5	7.00 "	6	12.10 A.M.	5	7.00 "	6	12.10 A.M.
6	6.55 "	7	1.10 "	6	6.55 "	7	1.10 "
7	6.55 "	8	2.10 "	7	6.55 "	8	2.10 "
8	6.55 "	9	3.15 "	8	6.55 "	9	3.15 "
9	6.50 "	10	4.20 "	9	6.50 "	10	4.20 "
10	6.50 "	11	4.35 "	10	6.50 "	11	4.35 "
11	6.50 "	12	4.35 "	11	6.50 "	12	4.35 "
12	6.50 "	13	4.35 "	12	6.50 "	13	4.35 "
13	6.45 "	14	4.35 "	13	6.45 "	14	4.35 "
14	6.45 "	15	4.35 "	14	6.45 "	15	4.35 "
15	6.40 "	16	4.40 "	15	6.40 "	16	4.40 "
16	6.40 "	17	4.40 "	16	6.40 "	17	4.40 "
17	6.40 "	18	4.40 "	17	6.40 "	18	4.40 "
18	6.35 "	19	4.40 "	18	8.10 "	19	4.40 "
19	6.35 "	20	4.40 "	19	9.00 "	20	4.40 "
20	6.35 "	21	4.45 "	20	9.45 "	21	4.45 "
21	6.30 "	22	4.45 "	21	10.40 "	22	4.45 "
22	6.30 "	23	4.45 "	22	11.40 "	23	4.45 "
23	6.30 "	23	12.00 M.	23	.....	..	....
24	12.40 A.M.	24	4.45 A.M.	24	12.40 A.M.	24	4.45 "
24	6.25 P.M.	24	12.00 M.	25	1.40 "	25	4.50 "
25	6.25 "	25	12.00 "	26	2.50 "	26	4.50 "
26	6.25 "	26	12.00 "	27	No Light.	27	No Light.
27	6.25 "	27	12.00 "	28	"	28	"
28	6.20 "	28	12.00 "	29	"	29	"
29	6.20 "	29	12.00 "	30	6.20 P.M.	30	8.20 P.M.
30	6.20 "	30	12.00 "				

OCTOBER, 1901.

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	6.15 P.M.	1	12.00 M.	1	6.15 P.M.	1	9.10 P.M.
2	6.15 "	2	12.00 "	2	6.15 "	2	10.10 "
3	6.15 "	3	12.00 "	3	6.15 "	3	11.00 "
4	6.10 "	4	12.00 "	4	6.10 "	4	12.00 M.
5	6.10 "	6	1.10 A.M.	5	6.10 "	6	1.10 A.M.
6	6.10 "	7	2.15 "	6	6.10 "	7	2.15 "
7	6.05 "	8	3.15 "	7	6.05 "	8	3.15 "
8	6.05 "	9	4.15 "	8	6.05 "	9	4.15 "
9	6.05 "	10	5.05 "	9	6.05 "	10	5.05 "
10	6.00 "	11	5.05 "	10	6.00 "	11	5.05 "
11	6.00 "	12	5.05 "	11	6.00 "	12	5.05 "
12	6.00 "	13	5.05 "	12	6.00 "	13	5.05 "
13	5.55 "	14	5.05 "	13	5.55 "	14	5.05 "
14	5.55 "	15	5.10 "	14	5.55 "	15	5.10 "
15	5.50 "	16	5.10 "	15	5.50 "	16	5.10 "
16	5.50 "	17	5.10 "	16	5.50 "	17	5.10 "
17	5.50 "	18	5.10 "	17	5.50 "	18	5.10 "
18	5.50 "	19	5.10 "	18	8.30 "	19	5.10 "
19	5.45 "	20	5.10 "	19	9.30 "	20	5.10 "
20	5.45 "	21	5.15 "	20	10.30 "	21	5.15 "
21	5.45 "	22	5.15 "	21	11.30 "	22	5.15 "
22	5.45 "	22	12.00 M.	22	.....	..	....
23	12.30 A.M.	23	5.15 A.M.	23	12.30 A.M.	23	5.15 "
23	5.40 P.M.	23	12.00 M.	24	1.40 "	24	5.15 "
24	1.40 A.M.	24	5.15 A.M.	25	2.50 "	25	5.20 "
24	5.40 P.M.	24	12.00 M.	26	4.00 "	26	5.20 "
25	5.40 "	25	12.00 "	27	No Light.	27	No Light.
26	5.40 "	26	12.00 "	28	"	28	"
27	5.35 "	27	12.00 "	29	5.35 P.M.	29	7.50 P.M.
28	5.35 "	28	12.00 "	30	5.35 "	30	8.50 "
29	5.35 "	29	12.00 "	31	5.30 "	31	10.00 "
30	5.35 "	30	12.00 "				
31	5.30 "	31	12.00 "				

NOVEMBER, 1901.

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	5.30 P.M.	1	12.00 M.	1	5.30 P.M.	1	11.00 P.M.
2	5.30 "	2	12.00 "	2	5.30 "	2	12.00 M.
3	5.30 "	4	1.10 A.M.	3	5.30 "	4	1.10 A.M.
4	5.25 "	5	2.10 "	4	5.25 "	5	2.10 "
5	5.25 "	6	3.10 "	5	5.25 "	6	3.10 "
6	5.25 "	7	4.10 "	6	5.25 "	7	4.10 "
7	5.25 "	8	5.10 "	7	5.25 "	8	5.10 "
8	5.25 "	9	5.35 "	8	5.25 "	9	5.35 "
9	5.20 "	10	5.35 "	9	5.20 "	10	5.35 "
10	5.20 "	11	5.40 "	10	5.20 "	11	5.40 "
11	5.20 "	12	5.40 "	11	5.20 "	12	5.40 "
12	5.20 "	13	5.40 "	12	5.20 "	13	5.40 "
13	5.20 "	14	5.40 "	13	5.20 "	14	5.40 "
14	5.15 "	15	5.40 "	14	5.15 "	15	5.40 "
15	5.15 "	16	5.45 "	15	5.15 "	16	5.45 "
16	5.15 "	17	5.45 "	16	8.20 "	17	5.45 "
17	5.15 "	18	5.45 "	17	9.20 "	18	5.45 "
18	5.15 "	19	5.45 "	18	10.20 "	19	5.45 "
19	5.15 "	20	5.45 "	19	11.20 "	20	5.45 "
20	5.10 "	20	12.00 M.	20	.....	..	....
21	12.30 A.M.	21	5.50 A.M.	21	12.30 A.M.	21	5.50 "
21	5.10 P.M.	21	12.00 M.	22	1.40 "	22	5.50 "
22	1.40 A.M.	22	5.50 A.M.	23	2.50 "	23	5.50 "
22	5.10 P.M.	22	12.00 M.	24	4.00 "	24	5.50 "
23	5.10 "	23	12.00 "	25	No Light.	25	No Light.
24	5.10 "	24	12.00 "	26	"	26	"
25	5.10 "	25	12.00 "	27	5.10 P.M.	27	7.35 P.M.
26	5.10 "	26	12.00 "	28	5.10 "	28	8.40 "
27	5.10 "	27	12.00 "	29	5.10 "	29	9.50 "
28	5.10 "	28	12.00 "	30	5.05 "	30	10.55 "
29	5.10 "	29	12.00 "				
30	5.05 "	30	12.00 "				

DECEMBER, 1901.

Table No. 1. Frund's Moonlight System.				Table No. 2. Standard Moonlight System.			
Date.	Light.	Date.	Exting.	Date.	Light.	Date.	Exting.
1	5.05 P.M.	1	12.00 M.	1.	5.05 P.M.	1	12.00 M.
2	5.05 "	3	1.00 A.M.	2	5.05 "	3	1.00 A.M.
3	5.05 "	4	2.00 "	3	5.05 "	4	2.00 "
4	5.05 "	5	3.00 "	4	5.05 "	5	3.00 "
5	5.05 "	6	4.00 "	5	5.05 "	6	4.00 "
6	5.05 "	7	5.00 "	6	5.05 "	7	5.00 "
7	5.05 "	8	5.50 "	7	5.05 "	8	5.50 "
8	5.05 "	9	6.10 "	8	5.05 "	9	6.10 "
9	5.05 "	10	6.10 "	9	5.05 "	10	6.10 "
10	5.05 "	11	6.10 "	10	5.05 "	11	6.10 "
11	5.05 "	12	6.10 "	11	5.05 "	12	6.10 "
12	5.05 "	13	6.10 "	12	5.05 "	13	6.10 "
13	5.05 "	14	6.10 "	13	5.05 "	14	6.10 "
14	5.05 "	15	6.10 "	14	5.05 "	15	6.10 "
15	5.05 "	16	6.15 "	15	8.10 "	16	6.15 "
16	5.05 "	17	6.15 "	16	9.15 "	17	6.15 "
17	5.05 "	18	6.15 "	17	10.20 "	18	6.15 "
18	5.05 "	19	6.15 "	18	11.20 "	19	6.15 "
19	5.05 "	19	12.00 M.	19	.....	..	....
20	12.30 A.M.	20	6.15 A.M.	20	12.30 A.M.	20	6.15 "
20	5.05 P.M.	20	12.00 M.	21	1.40 "	21	6.15 "
21	1.40 A.M.	21	6.15 A.M.	22	2.50 "	22	6.15 "
21	5.05 P.M.	21	12.00 M.	23	4.00 "	23	6.15 "
22	5.05 "	22	12.00 "	24	No Light.	24	No Light.
23	5.05 "	23	12.00 "	25	"	25	"
24	5.05 "	24	12.00 "	26	5.10 P.M.	26	7.30 P.M.
25	5.10 "	25	12.00 "	27	5.10 "	27	8.35 "
26	5.10 "	26	12.00 "	28	5.10 "	28	9.40 "
27	5.10 "	27	12.00 "	29	5.10 "	29	10.45 "
28	5.10 "	28	12.00 "	30	5.10 "	30	11.50 "
29	5.10 "	29	12.00 "	31	5.10 "	31	12.50 A.M.
30	5.10 "	30	12.00 "				
31	5.10 "	31	12.50 A.M.				

lighting. That is to say, the municipalities are charged for their arc lighting on the basis of its actual cost. In this country, on the other hand, the central station manager is asked to supply service on the basis of the charges of plants selected at random throughout the United States, with reference to their low rates and without regard to local conditions or whether the rates on their very face are absurdly inadequate. In too many instances the manager, through threats to establish a municipal plant or to bestow another electric lighting franchise, is compelled to acquiesce in unprofitable rates and the private consumer must pay the difference if the plant is to continue in business. The extra cost to the consumer rarely, if ever, takes the form of an increased charge, but comes through prices being maintained which otherwise could be reduced through actual lowering in cost of production. We venture to say that the prices for arc lighting in the majority of cases in this country at the present time are entirely too small on the basis of a fair division of cost between the public and private central station customer; and that in very many cases where the central station man believes he is getting a profitable rate an analysis of cost would show that the private consumer is being made to pay in excess in order to balance unrecognized losses in the street lighting service. To sum up, in perhaps all cases, a low rate for street lighting means a denial of the result of cheapened cost of electrical generation by modern apparatus to private consumers—the entire benefit of such lowering in cost being appropriated in meeting the unreasonable demands of municipal authorities upon the renewal of contracts.

A STUDY IN POWER TRANSMISSION.

We desire to call the especial attention of engineers to the study of the Paderno plant by Signor Guido Semenza, summarized in our last issue. To make an exhaustive investigation of a large transmission system is a task requiring much time, labor and expense. We, in America, are too busy and hustling to afford the reflective examination of so grave a problem unless driven to it, and the engineering profession owes a lasting debt of gratitude to Signor Semenza for the detailed information put at our command. Our Italian friends seem especially facile in the treatment of transmission work, and their experience is of unusual value.

The Paderno plant is one of unusual interest. In the first place, its output is big enough, nearly 4000 kilowatts, even at the date of the paper; and the line is long enough (25 miles) to correctly represent commercial conditions of the larger class. Second, it generates current at a voltage higher than is commercially used elsewhere, and finally it serves a typical polyphase distributing system, including all the familiar types of apparatus. The generation of current at 15,000 volts in the armatures is a step beyond regular American practice, and it seems to have been practically successful, as indeed it should have been in machines so large as those at Paderno. But the experience with these generators shows evidence of the resonance that lies in wait for the transmission engineer on this side of the water as well. Two inches is certainly not a normal striking distance for the voltage, and from the standpoint of pyrotechnics a three-phase arc at 15,000 volts must be highly edifying. It would be interesting to know the details of such an occurrence.

The moral is pointed, however, that one should be cautious in using such high voltage at the generators. The fact is that high voltage generators are rather apt to encourage resonance effects, if constructed in the usual manner. To get adequate chance for insulation, such machines are generally made with but one slot per phase per pole, and with this construction it is not at all easy to obtain a wave form nearly sinusoidal, or a generator of low armature reaction. There is a consequent abundance of harmonics that may cause trouble either on the line or in the machines. The Paderno dynamos, however, seem to be of rather good regulation on non-inductive load, but, as might be expected, somewhat sensitive to inductive load. On the line there seems to have been experienced the usual troubles with lightning in spite of the iron pole line and the supply of lightning arresters. If we were constrained to give a definition of lightning arrester, we fear it would have to be in about the following terms: "Lightning Arrester—An apparatus for the protection of lines and generators, which sometimes diverts lightning." At Paderno they seem to have been favored with shut-downs from this cause in two seasons. Lightning protection is likely to be rendered more difficult by resonance which hinders that fine adjustment of the air-gap which would otherwise be desirable.

Another very interesting feature of Signor Semenza's report is the very careful investigation of the power factor of the load. The very large use of synchronous motors in the Paderno plant is striking and the result is highly satisfactory, so far as the power factor is concerned. The induction motor part of the load seems to give about the same results as are found in similar cases in American practice, and the same difficulty of underloaded motors seems to have been encountered. If induction motors are worked somewhere near full load little trouble with lagging current is met, but if many of them are habitually worked underloaded the case may be quite different. The synchronous motors employed for driving dynamos and worked with overexcited fields, seem to have acted as an almost complete corrective of the inductive load elsewhere, so that the net result of 0.91 for the power factor of the system is excellent, particularly when one considers the effect of the reducing transformers. Synchronous motors form a convenient and useful part of most transmission systems, but we know of few cases in which they are so advantageously used on so large a scale as at Paderno.

But perhaps the most striking part of this investigation is that devoted to the line. In passing, we may note with some pardonable pride that insulators found to give the best results followed American practice closely, although actually made in Milan. The line itself is rather complicated from the American standpoint, consisting of six complete three-phase circuits about No. 6 in size. Experience here would indicate the advisability of using much higher voltage with raising transformers, and employing a simpler line. The impedance factor of the line was found to be 1.35, which is about what it should be, while the charging current proved 1.03 amperes. By some very ingenious measurement Signor Semenza separated this into its true capacity and leakage components, and found the latter to be not quite a quarter of an ampere. If one considers the gloomy predictions of a few years ago on the subject of leakage this result is amusing, and it certainly speaks volumes for the quality of the insulators on so long a line. Speaking broadly, one may say that unless under very extraordinary conditions leakage cuts very little figure in the working of a modern transmission system. As to the charging current, it is likewise a matter of small importance, and if it ever gets at all annoying it can be controlled, as it is in some American plants, by distributed inductance in the shape of induction motors or other inductive load at local points along the line. We are not surprised that Signor Semenza found ground detectors to be of little use on these high voltage lines, but we cannot help feeling that for high voltage transmission iron poles are an element of danger to continuity of service, and that the system would be somewhat more reliable without them. In general, however, the Paderno plant seems to be a remarkably well planned one, for which Signor Semenza deserves much credit, as well as for his most interesting investigations.

Death of W. H. Lawrence.

W. H. LAWRENCE.

Washington H. Lawrence, president of the National Carbon Company, of Cleveland, died at his home at Dover Bay, near that city, Friday morning, Nov. 23. His death was due indirectly to his participation in a lawn tennis game last July in which he broke his arm while swinging a ball, holding the racquet in his left hand. As he swung the ball he experienced a pain in his arm, and efforts to use it proved futile. Examination showed that the arm was broken. The bone failed to knit and Mr. Lawrence suffered greatly from the injury. Several weeks ago it was decided to amputate the arm, and this was done last Wednesday. A chill set in which proved fatal.

Mr. Lawrence was born at Olmstead, near Cleveland, Jan. 17, 1840. In early manhood he went to Kansas and Missouri. He returned to Cleveland in 1863 and engaged in the manufacture of Domestic sewing machines. He became interested in the early experiments of Mr. Charles F. Brush, inventor of the famous arc lighting system that bears his name, and furnished much of the original capital for the organization of the Brush Electric Company, holding the position of general manager and serving as president of the company. Mr. Lawrence displayed much pluck and energy in building up the industry, and the company came to have a capital of $3,000,000, the establishment under his charge being the largest of its kind in the world.

In 1882 Mr. Lawrence severed his connection with the Brush Company and disposed of a large part of his interest in it. He then invested heavily in Cleveland real estate and spent his time in its management, but in 1886 he turned his attention again to electricity and went into the manufacture of arc light carbons, which had in earlier days commanded much of his thought and energy. Many of the improvements in carbon production are distinctly traceable to his ingenuity. The National Carbon Company was formed by Mr. Lawrence, Myron T. Herrick, James Parmalee and Webb C. Hayes, and in 1891 the company, purchasing 115 acres on the outskirts of Cleveland, put up the largest carbon factory in the world. Its capacity cannot be less than 250,000,000 carbons a year, and it has many allied branches of work in furnace carbons, battery carbons and brush carbons.

Mr. Lawrence was not only the guiding spirit of this great enterprise, but was interested in other advances, such as those of the Sperry Electric Railway Company, and in many respects his career was typical of the great industrial and electrical development of the country. It is estimated that he leaves an estate worth $5,000,000.

American Institute of Electrical Engineers.

At the one-hundred and forty-eighth meeting of the Institute, held at New York and Chicago Nov. 23, a paper was presented by Mr. B. A. Behrend, of Erie, Pa., on "The Mechanical Forces in Dynamos Caused by Magnetic Attraction." The author exhibited a few lantern slides of the machines from which the data in his paper were derived, also a very excellent portrait of Helmholtz.

A paper was also presented by Mr. Henry Floy, of New York City, on "The Plant of the St. Croix Power Company, of Wisconsin." The papers were discussed at New York by Messrs. Behrend, Billberg, Dunn, Henshaw, Hering, Mailloux, Pope, Rice, Sheldon, Thompson, Wheeler and Wolcott.

At the meeting of the executive committee in the afternoon the following associate members were elected: George Porter Baldwin, sales agent, John Martin & Co., San Francisco, Cal.; Warren James Ballou, electrician, Woonsocket Electric Machine & Power Company, Station 2, Woonsocket, R. I.; V. G. Converse, engineer and manufacturer, Third Street and Pennsylvania Avenue, Pittsburg, Pa.; M. A. de Chatelain, professor of electrical engineering, Mining Institution and Electro-Technical Institution, Wasily Ostrow, St. Petersburg, Russia; Edward Andrew Deeds, head of engineering department, National Cash Register Company, Dayton, Ohio; George Hafer, Jr., general superintendent and electrical engineer, Cincinnati Gas Company, electrical department, Cincinnati, Ohio; James Cezanne Kelsey, switchboard trouble manager, Northwest Telephone Exchange Company, Minneapolis, Minn.; Harry Russell Leyden, manager Hamilton Electric Light & Cataract Power Company, Hamilton, Ont.; C. M. Lowther, sales engineer, Crocker-Wheeler Company; George Henry Sethman, mechanical and electrical engineer, Skinner & Sethman, 2243 Irving Street, Denver, Colo.; Frank W. Springer, assistant professor electrical engineering, University of Minnesota, Minneapolis, Minn.; Philip Kossuth Stern, practicing electrical and mechanical engineer, 130 Fulton Street, New York; Nathaniel Marion Snyder, county surveyor for Scotts Bluff County, Gering, Neb.; George Alexander Walkem, electrical and mechanical engineer, P. O. Box 595, Vancouver, B. C.; Leon Byron Woodworth, electrical engineer, New Heriot Gold Mining Co., Johannesburg, S. A.

The paper by Mr. Behrend was devoted to a consideration of the mechanical effects that are produced by an unequal distribution of the lines of induction around the surface of an armature, when the axes of armature and field are not coincident but eccentric. Everybody, he said, who has designed large generators or motors with small clearances is aware of the tremendous mechanical effects of the magnetic forces and the necessity for obviating the same, lest an otherwise successful design be balked by the bending of a shaft or even the collapsing of the magnetic frame. Mr. Behrend commenced the treatment by deducing a formula by which to determine the mechanical force exercised on a piece of iron in a uniform magnetic field formed by two parallel surfaces. He then proceeded to the deduction of a formula to express the magnetic attraction between two cylinders, the axes of which are slightly displaced with respect to each other. Tests were made on a 300-hp 2000-volt inductor generator in order to check the formula and a sufficiently close agreement between the calculated and experimental results was found to exist. In this case the air-gap of the top of the armature was .26 cm and at the bottom .46 cm. The calculated force tending to lift the armature from its bearings was found to be 7400 kg. and the observed force was 8400 kg.

The paper by Mr. Floy gave a detailed description of the transmission plant of the St. Croix Power Company of Wisconsin, by means of which power is transmitted from Apple River to St. Paul, a distance of 27 miles, at a pressure of 25,000 volts. The transmission line consists of two three-wire three-phase transmission circuits, each consisting of 24½ miles of overhead bare copper wires and 3 miles of underground cables connecting the generating plant at Apple River with the distributing station in St. Paul. One of the underground circuits employs rubber and the other paper cable.

The calculated resistance of each conductor between the generating and distributing stations is 23 ohms; the drop in voltage between the same points for 3000 kilowatts delivered with a 90 per cent power factor and at 25,000 volts initial pressure is figured at 7.7 per cent, both lines being operated in multiple. The capacity of the generating plant is 2000 horse-power continuously, but during most of the year nearly twice that amount of power is available. At present four main sets of "Victor" water wheels are installed, space being reserved for a fifth unit. Each set consists of two 36-in. "Victor" wheels mounted horizontally and directly connected to a 750-kw General Electric three-phase generator of 800 volts and 60 cycles at 300 r. p. m.

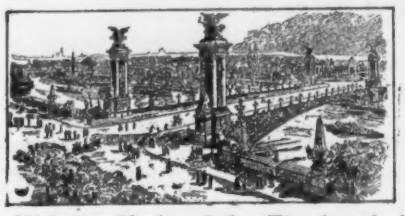
Some interesting tests made on the transmission line are reported in the paper. It was found that the charging current of either line was practically the same, and unchanged whether both ends of the other line were disconnected from everything or whether its three ends were tied together and connected to good ground. Some measurements showed that the charging current for the rubber cable was a little more than double that of the paper cable. From the standpoint of overcoming reactance of the circuit the larger capacity of the rubber cable as implied by the larger charging current is the more desirable. The following are the results of some of the charging tests at 25,000 volts:

The charging current for three bare wires alone was 2.25 amperes, and for two bare wires alone, 2.5 amperes; for paper cables alone, 3.1 amperes, and for one circuit including paper cables, 4.9 amperes.

Mr. Floy concluded with the statement that no trouble whatever has been experienced with resonance, harmonics, etc.

The discussion dealt chiefly with the heavy guarantees exacted from the cable makers, some of whom had declined to meet the requirements; and the question of aluminum was considered. Mr. Floy said it would have been cheaper by several thousand dollars to use aluminum instead of copper, but the capitalists preferred not to run the risk presumed to exist in connection with the newer metal.

Lighting the Alexander III. Bridge, Paris.



THE fine new avenue in Paris from the Champs Elysées to the Hotel des Invalides is completed by the new bridge across the Seine, called the Alexander III. Bridge, of which the first stone was laid by Czar Nicholas II. in 1896. The length is 360 ft. and width 131 ft., and a single span is used from bank to bank of the river. It has thus far constituted a part of the Exposition of 1900, but has now been thrown open to the public. The lighting effects are well arranged, both arc and incandescent lamps being used. The same cables supplying current are those feeding the Monumental Gate, noted in a recent issue, and a transformer station is provided near the abutment at the southwest corner, in a vault under the steps. The transformers are supplied by Schuckert & Company, there being three of 11 kilowatts and one of the same size in reserve.

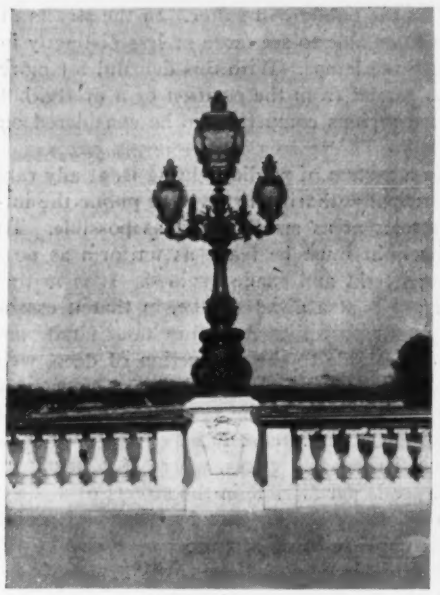


FIG. 1.—ORNAMENTAL FIXTURE.

FIG. 2.—COLUMN STATUARY AND LAMPS.

FIG. 3.—ORNAMENTAL FIXTURE.

FIG. 4.—GRANITE LAMP POST PYRAMID.

The city authorities refused to allow the 5000-volt mains to be laid in a properly constructed conduit in entering the transformer house, and the lines had to be carried over the door sill, where they remain, subject to injury from accidental blows. The insulation is, however, exceedingly high and the construction strong.

At the four corners of the bridge the massive stone columns surmounted by golden equestrian groups command universal admiration, and throughout there is manifest an unusually artistic treatment of decoration. The bronze balustrades are ornamented with twenty-eight candelabra of three lanterns each, by M. Gaugié, and the ends of each balustrade have still more elaborate candelabra with five lanterns and four tube lamps representing bulrushes, these being the work of MM. Morice and Marsoulle, who have designed handsome standards representing the "Genii of the Water"—three boy figures on each with fishes, tridents, etc. In the centre on the down-stream side there is a group in bronze representing an allegory of the Franco-Russian alliance, and backed by ten bulrush lamps forming a crown. On the up-stream side there is at present only a group of flags, because the model for the bronze figures was destroyed by fire in December, 1899. The new model has been made and the finished group is in the grounds near by, awaiting the close of the Exposition for putting in place. At the approaches to the bridge, at all four corners, are pyramids of stone with four lanterns on brackets, each

FIG. 5.—CLUSTER OF BULRUSH LAMPS.

having four 16-cp lamps, or a total of 64 lamps for the four pyramids. The large corner candelabra on the balustrades have five lamps in the upper lantern, and four in each of the others, while the bulrush bulbs have each a cylindrical or tubular lamp. Each of these corner groups has therefore 25 lamps, or 100 in all. The twenty-eight can-

delabra with three lanterns have four lamps in each lantern, or a total of 336 lamps. Finally, the centre groups have 10 lamps each. The bulrushes on the three-lantern candelabra are in bronze. The total number of lamps on the bridge is thus 520, all of 16 candle-power and 110 volts. The candelabras are made by La Carrière & De la Tour, of Paris.

The arc lighting is quite independent of the Exposition, and is on the mains of the System of the Left Bank (Secteur de la Rive Gauche). Ten Rechniewski arc lamps of 10 amperes are used, and the e. m. f. of the mains being 220 volts, each arc lamp receives current through a small transformer which reduces the potential to 60 volts.

Two circuits are used for the incandescent lighting, one called the regular circuit and the other the fête circuit. The regular circuit comprises the lamps in the upper lanterns of the candelabras and the lamps in the pyramid lanterns, and the fête circuit includes the remainder of the lamps. Each circuit is in two branches, so that there are really four circuits, the regular circuits having 98 lamps on each and the fête circuits 152 lamps each. The circuits are divided for the two ends of the bridge, one regular circuit having therefore 16 lamps on each of two pyramids, 5 lamps on each of two corner candelabras, 4 lamps in two lanterns of seven candelabras for up-stream side, and same for down-stream side, a total of 98 lamps. The fête circuit has 8 lamps on fourteen candelabras, 16 lamps on two candelabras and 4 bulrush lights on two candelabras, also the crown lights behind one group; total, 162 lamps. The total for the bridge is therefore 196 + 324 = 520 lamps. The regular circuits are run with cables of 60 sq. mm. cross section, and the fête circuits 90 sq. mm.

FIG. 6.—ARC LAMP POST.

The work of installation both in the Monumental Gate and the Alexander III. Bridge was done by the Cie Electro-Mécanique, whose engineer, M. Durand, has given many details relative to the work accomplished by them.

It was originally intended to use the fête circuits for special occasions, in connection with the regular circuits, such as on Fridays and Sundays and holidays. But the whole number of lights has been switched on every evening, so that the bridge is always fully illuminated at night. The arc lamps on the bridge form part of the row bordering the Avenue Nicholas II., but are, as has been pointed out, on the city mains of the Left Bank district. The lamps between the Fine Art Palaces are partly on the Exposition circuits and partly on the city mains of the "Secteur Clichy," every alternate lamp down the central row being on the latter circuit. It is justly asserted that the bridge is the most ornamental of its kind in the world, and that as an individual piece of bridge lighting it is superior to anything that can be found in Europe.

Remarkable Growth of the New York Telephone System.

During the 10 months from Jan. 1 to Oct. 31, 1900, the New York (Bell) Telephone Company made the remarkable gain of over 12,500 telephone stations, of which about 10,500 were added in Manhattan and the Bronx, and the remainder in its Westchester Division. If the present rate of growth continues, and there is every reason to believe that it will, at the end of the present year the company will have a total of not less than 60,000 stations, of which about 55,000 will be in Manhattan and the Bronx, and about 5,000 in the Westchester division. This will be a net increase of 16,800 stations in the year, or 40 per cent of the system as it stood at the beginning of 1900.

While making this unparalled increase in the number of telephone users, the New York Telephone Company has been engaged in converting its metropolitan system from magneto to relay working, involving the reconstruction of the exchanges, and the substitution of common battery instruments for the magneto equipment at all subscribers' stations. At the end of the year only two exchanges, Cortlandt and Franklin, will remain on the magneto plan, and the new relay exchanges for those districts will probably be completed before July 1, 1901. During the year eight new exchanges have been opened in the Bronx and the Westchester division.

Street Lighting by Electric Lamps.

(With special reference to the systems in use at Croydon, England.)

BY F. H. MINSHALL.

IT is now becoming more and more realized that in our present state of civilization well lighted streets are a necessity, and that it is not sufficient merely to indicate the direction of the road by placing lamps as far apart as the public will suffer. In the streets of a town people now require to be able to see more or less distinctly in any part of the road between the lamps. With this demand for more light, the electric lamp has passed from the position of a pretty, but capricious rival, to that of a serious competitor to be considered on equal terms with gas.

The first consideration in a system of public lighting is, at any rate when undertaken by a municipal authority, to give the public the impression of well lighted streets at as small a cost as possible. To obtain this impression, the light must be made as uniform as possible, and sharp contrasts of light and shade avoided. It is in this one respect that the arc lamp is at a disadvantage, in that it essentially consists of what is practically an intensely luminous point, and that is the condition most favorable to the production of deep, well defined shadows. If, of course, the adjacent lamps are sufficiently near, the shadows cast by one lamp cannot be very dark, but there is still the objection that the light is too intense to be viewed with comfort or safety. It is only in large open spaces, where high posts can be used, that an unshaded arc is permissible in the streets of a town.

We are obliged, therefore, to screen the arc by means of globes and diffuse the light at the expense of from 10 to 60 per cent of the total illumination, according to the type of globe used.

Clear glass globes will absorb about 10 per cent of the light and opal globes of ordinary thickness about 60 per cent, and this proportion of the light is absolutely wasted. The screening power of a globe is most vividly in evidence when the globe has a hole in it, through which a pencil of rays can uninterruptedly pass out. It is now becoming the practice to use opaline globes, however, which can be obtained of any degree of opacity, from almost clear glass to the thickest opal, it being recognized that to screen off more light than is absolutely necessary to comfort is a foolish waste.

Where enclosed arcs are used, it is unnecessary to use anything but clear globes, as it is found that the slight deposit formed on the inner globe is sufficient to prevent an unpleasant glare, and the gain in efficiency is very marked. But, of course, in this case, for the first few hours after fresh trimming and cleaning, until the deposit begins to form, the arc itself can be plainly seen.

Of a number of systems of lighting, the best is that which gives the greatest amount of light, most evenly distributed for the least total cost, including running expenses and interest on capital.

A comparison on this basis of the various systems in use would be very interesting, but data of the actual amount of illumination are difficult to obtain.

It may be taken as a general rule that the watts actually consumed per lamp in the lamp lie between the values 350 and 750, the average being about the mean of these two values, i. e., 550 watts; and the problem is to decide in what type of lamp this power may be used to the greatest advantage.

Although, light for light, it is cheaper to run arc lamps than gas, in changing over to a new system of lighting so much more is expected of the new light that this advantage is generally overbalanced by the cost of the extra light supplied.

The following table gives approximately the energy required in a few types of arc lamps in common use, as measured on the Croydon, England, plant:

No.	Type.	Current.	Volts.	App. watts.	Actual watts.	Power factor.
1.	Rectified current, open arc	11.8	47	550	520	0.95
2.	Enclosed alternating	4.7	200	940	650	0.69
3.	Low wattage chokerless type.	3.0	200	600	420	0.74
4.	Series alternating enclosed arc	10.0	70	700	530	0.76
5.	Enclosed alternating (a)	—	—	—	—	—
6.	" " (b)	6.7	115	770	510	0.66
7.	" " (c)	4.4	206	906	540	0.60
8.	Alternating, open arc series.	21.0	37	778	550	0.71

Lighting is required in the streets for about 3710 hours in the year, if the lamps are on from dusk to daylight. This figure is obtained

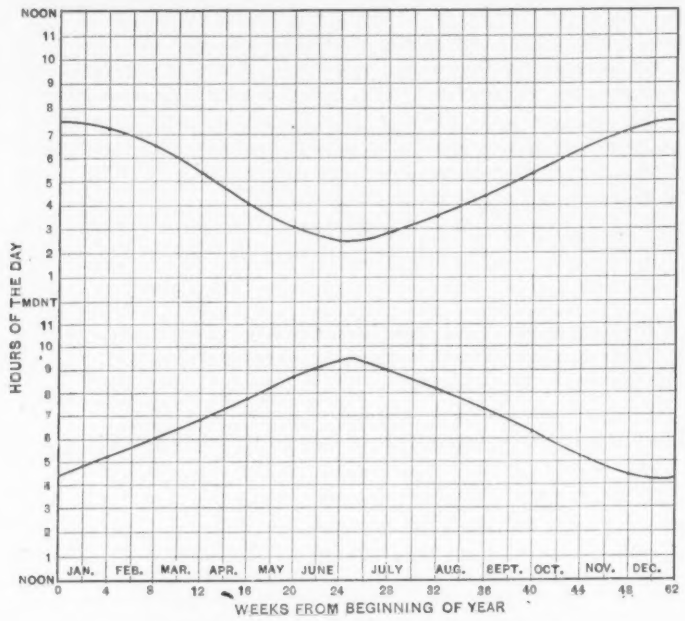
from the curve in the accompanying illustration below, which shows the hours of switching on and switching off the Croydon street lamps during the past year. The unsymmetrical appearance of the curve is due to the dark, cloudy mornings common in January, February and March, and the foggy evenings in November and December.

Hence the cost of energy at the generating station will be per year, for a 450-watt lamp, $50.40; for a 550-watt lamp, $61.20; for a 650-watt lamp, $72, taking the cost per unit at the station as 0.0313 cent.

This low cost per unit may be taken owing to the fact that there is no plant specially put down for arc lighting, the private lighting plant being installed of sufficient capacity to deal with both demands, and the public lighting also helps to improve the load factor.

Allowing for losses in transformers and mains in the case of alternating parallel lamps, the distribution efficiency will be about 90 per cent, and, in the case of rectified series lamps, 85 per cent, so that the actual amount annual cost of energy per lamp is, for 450 watts per lamp, $55.70; for 550 watts per lamp, $72; for 650 watts per lamp, $80.20. To this must be added interest on capital and depreciation say 5 per cent interest and 5 per cent depreciation on $168 per lamp = $16.80 per lamp.

It is found that the annual consumption of carbon per lamp per year in Croydon is, for an all-night lamp, as follows: 550-watt open arc rectified current lamp (233 ft. 20 mm. cored, 237 ft. 13 mm. solid), costing $8.46; 650-watt alternating lamp, enclosed (*a*) (67 ft. solid.



LIGHTING CURVES FOR ONE YEAR. CROYDON.

31 ft. cored), costing $2.26; 650-watt alternating-current arc, enclosed (*b*) (109 ft. cored), $4.24.

There is also the extra annual cost of the special rectifying apparatus for the rectified current lamps, over that of the ordinary transformers required for the other lamps, which amounts to about $3.36 per lamp.

Allow also for $0.48 per lamp per year for replacement of broken globes. The total running cost per year per lamp is thus as follows:

For a 550-watt rectified current open arc.....	$108.30
For a 450-watt alternating-current enclosed arc.....	80.02
For a 650-watt alternating-current enclosed arc (*a*)..	104.50
For a 650-watt alternating-current enclosed arc (*b*)..	106.48

This does not allow anything for annual cost of the share of the station plant used for arc lighting.

As regards the lamps, we may use an open arc or an enclosed, and with the former, single or double carbons. As regards the system, we have to choose between alternating and direct current, and as regards the arrangement, we must decide whether running the lamps in series or in parallel, or in combinations of series and parallel, best meet the conditions of supply.

It will readily be conceded that no engineer would use an alternating current lamp where he could, with equal facility, employ one with direct current; the reasons being that the latter will give more light per watt supplied, will give a better distribution of the light and will run silently. But, even in the case of a town supplied with direct current there are often difficulties in economically running the arc lamps.

A 10-amp. open arc requires about 45 volts on the lamp, so that on a 100-volt circuit two may be run in series with an additional resistance of 1 ohm in the circuit, which, however, wastes 100 watts, i. e., 50 watts per lamp, and so reduces the efficiency. On 200 volts, four may be run in series with the same efficiency, and on 405 volts nine will run. In this case, there need be no resistance, but the drop of pressure in the cables and leads will have to be allowed for, so that about 415 volts will actually be required. With this arrangement, however, the failure of one lamp will either cause the others to go out or else to "flare," owing to the increased voltage, unless each lamp is supplied with a resistance automatically put in circuit; this resistance, however, to absorb 450 watts at 10 amperes needs to be very cumbrous.

In the case of enclosed lamps for direct current, since the required voltage is higher, only one can be run off 100 volts, three off 220 and six off 440, with a corresponding increase in the ratio of watts used per lamp to watts supplied.

Where a high voltage direct current supply is available, a large number of lamps may be run in series, up to 40 or 50, but, as it seldom happens that the voltage necessary for the number of lamps required coincides with the standard pressure of supply, either a motor transformer or a separate direct-current arc lighter must be put down.

In a large series of lamps, the risk of failure of more than one or two at one time is small, so that a constant current machine is not a necessity; but as the cost of such a machine is very little more than one built for constant pressure, the former is generally used.

It is unfortunately almost always the case that, where electric lighting is introduced into a town, during the first year or two of working only a comparatively small number of public lamps are arranged for, and what there are must be made to take their supply from the machines put down for private lighting, in order to improve the load factor. Were it possible to foresee future developments it would often be found to be wiser to put down special constant current arc lighters to run the lamps in several circuits with from 30 to 40 lamps in series in each. These machines would run at a very high load factor, and would take the place of, rather than being an addition to, a portion of the private lighting plant.

One other reason why this is not more often done is the fact that many of the types of direct current arc light machines on the market have a very low efficiency, and the cost of the useful energy supplied to the lamps is, therefore, excessive. This cost, added to the heavy annual expense of a high pressure underground cable, the use of which is compulsory in an English town, renders a series system for a district at a considerable distance from a generating station quite out of the question, assuming, of course, that low tension feeders are available to carry the current for the arcs in the district under consideration.

Consider now the case of a high-pressure alternating-current supply, in which no special generators have been provided for arc lighting. We have the following possible methods of running:

1. Motor-generator transforming high-tension alternating current to high-tension direct current running series circuits (*a*) from central station (*b*) from sub-stations.

2. Rectifiers transforming high-tension alternating current to high-tension unidirectional pulsating current, running series circuits.

3. Alternating arcs, open or enclosed, run in single parallel (*a*) off low-tension mains, (*b*) off separate low-tension mains from sub-stations.

4. Alternating arcs run in series off low-tension distributors.

5. Alternating arcs run in series off special transformers in sub-stations at high voltage.

Method (1) would certainly be less economical in running than putting down a separate engine and arc light machine, owing to the double loss in the motor-generator. In (1) *b*, although a rotating machine might run for a time unattended in a sub-station, the risk of failure would be great. The heavy capital expenditure, however, of this system alone is sufficient to prevent its adoption.

Method (2) is one which is very largely adopted in England, and, in spite of the bad reputation attached to rectifiers, in capable hands they are practically as reliable as the main generating plant. The one fault of the rectifier is the probability of the motor running out of phase should anything cause a sudden change in the speed of the alternators, such as a short-circuit current on the main cable, or an alternator being switched in or out badly. Should the motor go out of phase it may be synchronized again in about a minute, but, during that time, the alternating current is passing through the lamps, causing them to "pump."

The lamps themselves are very efficient and regulate well, but, owing to the somewhat low efficiency of the direct-current transformer attached to the rectifier, the gross watts taken per lamp amount to about 650 for a 12-amp. lamp. The distribution of the light is practically as good as with a direct-current lamp.

Method (3) is also adopted in many cases, the arc being generally of the enclosed type. The voltage required on the lamp is about 70 in the latter case, as against 35 in the case of an open arc. The voltage of the supply must be either transformed down to this value or reduced by means of a choking coil. Both means are in most cases adopted, and there is some difficulty in finding room for the compensator (as the special transforming device is called), the choker and the switch, in the bottom of the post.

There is, however, a type of lamp now rapidly coming into favor in England which includes the transformer and choker within the lamp itself. As the transformer is also made to act as the feed regulator, the total weight of the lamp, though high, is not excessive. The arrangement gives a large margin of power for working the feed mechanism, and requires nothing but a simple switch between it and the mains. This is the Lewis lamp. The lamp is, for an alternating lamp, efficient and has also a fairly high power factor, which is of great importance in connection with the loss in mains. A recent development of this lamp omits the choking coil altogether, and the lamp consists merely of a special moving coil transformer which gives the lamp the required voltage, and also acts as the feed regulator. The power factor of this lamp is between 70-80, since we have practically the case of a fully loaded transformer.

Before considering further different types of lamps, it will be well to pay some attention to the different ways of feeding them. The distance between adjacent posts must necessarily be determined to a great extent by the positions of side streets and the amount of traffic A light is required at corners of roads, and more light is required where there is more traffic. The average distance apart of the lamps, however, is seldom below 40 yards or above 80 yards. In Croydon, for instance, a standard of 60 yards is adhered to where possible, with lamps taking about 530 watts in the case of rectified current and about 650 watts in the case of alternate current. With lamps placed at this distance apart it is possible to read easily a newspaper at any point between two lamps.

Much is made of the saving in copper effected by using a series system, and, where there is no low-tension network existing, it is true that it is the only system worth considering from an economical point of view. But where a low-tension system exists, even when separate arc cables are required, single parallel lighting is in cost of copper on an equal footing with series lighting, assuming that feeding points are available on the route every 1400 yards or less.

For mechanical reasons, a series conductor of less than .025 sq. in. section, i. e., 7-16 cable, would not be advisable, and a cable of this section is more economical than one of .06 sq. in. section, i. e., 19-16 cable, under the conditions which obtain at Croydon, as the following figures show.

Assuming the lamps arranged as at Croydon, i. e., 60 yards apart and on two separate circuits, so that the lamps on the same cable are 120 yards apart. If lamps in single parallel taking 4.7 amperes each are used on a cable of .025 sq. in. section, only five can be fed from one point if the voltage drop is not to exceed 16 volts in 208, i. e., 4 per cent. above and 4 per cent below the standard. This drop is allowable, but the lamps will not run well with a larger variation. This gives 1150 yards between feeding points. If lamps taking only 3 amperes are used, the number may be increased to six, and the drop is then 14.5 volts on the same sized cable. This gives 1400 yards between feeding points allowable.

In this latter case, the loss in watts due to the resistance of the cable is 185. Suppose a cable of .06 sq. in. section were used, the drop with six 3-ampere lamps 120 yards apart will be only 6 volts, and the watts lost only 77. The difference of these two amounts of wasted energy is 600 kw-hours per annum on the assumption that one circuit is switched off at midnight. This means, at $0.020 per kw-hour for the extra energy required, $12 per annum, which would be saved by putting in the larger scale.

The difference in cost of these two cables for 1400 yards is $588, if concentrics are used, so that the annual cost due to interest and depreciation will be $58.80 more for the larger scale as against the $12 saved in energy. If a .06 sq. in. triple concentric cable is used, the extra annual cost for cable will be $22.80, and the saving in energy will not be so much as before. This assumes only one trench excavated for both cables.

With arc mains laid in this way, lamps may be run with equal facility in single parallel off 200 volts, on the three-wire system off 400 volts, or five in series off 400 volts if of the enclosed type, and eleven in series off 400 volts if they are open arcs. This is method (4).

Series and parallel systems are much more on an equality as regards possible extinction of the lamps than is generally supposed. Taking first an "earth" on one of the lamps, a series system originally completely insulated will be unaffected, whereas on a parallel system, with one conductor earthed as on a three-wire system, it will have the effect of a short circuit, if on the live pole of the lamp, and will cause the circuit to be shut down. It is true that there will probably be only six or seven lamps on the parallel circuit, and possibly 30 or 40 in a series on one cable. A short circuit on the cable will, of course, in either case cause the extinction of the lamps on that cable.

A lamp which "goes to frame" without making an "earth" will, in the case of a series lamp, simply be out, and, in the case of a parallel lamp, will blow its fuse, and so cut itself out.

There is, of course, need for higher insulation on a series circuit of many lamps. So far it has been assumed that the arc lighting cables are entirely separate from the private lighting distributors but, in many cases, the lamps are connected to the same cables as the private lights. This necessitates a man visiting every post to switch on and off, thus throwing away the advantage of being able to control a whole district from one point. Where separate cables are used, the risk of total darkness due to a cable breakdown is halved, but, of course, the capital expenditure is heavy. If the cables for arc lighting are laid at the same time as the distributors, one excavation does for both, and, as in the case of small cables, the cost of excavation and making good exceeds the value of the cable, this is a very important consideration.

The following figures show that it is not always even economical (putting aside the greater freedom from failure) to connect the lamps to the distributors for private lighting.

One man will be able to switch off, say, 40 lamps on a circuit 4800 yards long in 1¼ hours, including his time in reaching the circuit and returning.

	Per annum.
Man's time on round, 1¼ hours, $0.24 per day per circuit	$78.00
Extra cost of distributor for carrying extra current, say, $0.24 per yard, 4800 yards.....$1,152.00	
Annual cost of same for interest and depreciation	115.20
Extra units (kw-hours) required, 40 lamps for one-half hour per day = 3285	
Annual cost at $0.020 per unit	65.70
Total	$258.90
Annual cost of interest and depreciation on 4800 yards of cable .025 sq. in. section	$201.50
Annual cost of share of pilot wire and automatic switches	6.00
Total	$207.50
Annual saving in favor of separate cables	$51.30

It is very desirable also to split up the lighting of a street into two circuits in order to reduce the risk of total darkness, and it is also better to put two lamps alternately on opposite sides of the road. This, again, adds greatly to the initial outlay, but if the cables be put all together in one trench and leads taken across the road at intervals, the great part of the expense is saved, as the following calculation shows.

Assume, as before, lamps 120 yards apart on one cable, so that one crossing will be required every 120 yards.

Cost of crossing, 10 yards of cable and excavation	$7.80
If across a tramway with double track, allow	18.60
Cost of separate excavation and making good, 120 yards of gravel	43.20
Ditto, 120 yards of asphalt	$50.40

That is, the minimum saving is $24.60 per 120 yards of route and the maximum saving is $40.20 for the same length.

It is the standard practice in Croydon to make alternate lamps half-night lamps, i. e., the lamps on one circuits are switched off at midnight, but, from the point of view of the station engineer, this is not to be encouraged. Where separate arc mains are referred to, they, of course, only extend back to the sub-stations, except in the case of mains for rectified lamps, so that an attendant must visit each sub-station in order to switch on and off the lamps. Where,

however, pilot wires are available, the lamps may be switched on and off by means of magnetic switches, worked from the central station. In Croydon, the lamps in the outlying parts of the district are switched off by this means.

The last method (5) has now to be considered. This is a series system containing a number of open alternating-current arcs, and we must allow 37-40 volts per lamp, putting in a special transformer, either at the generating station or at a sub-station. The latter saves in cost of cable, but necessitates an attendant visiting the sub-station. As, however, an attendant must always go the round to report the lamps, this is of little consequence. Lamps of this type may be obtained for all powers, from 8 amperes and 400 watts upwards. In some cases, e. g., at Hammersmith, they are run from constant potential transformers, and each lamp supplied with a compensating resistance which is automatically put in circuit if the lamp should fail.

A choking coil is placed in series with the lamps and is used as a regulator in switching on the lamps. An interval of about fifteen minutes elapses before the lamps settle down to a steady state.

The compensating resistance is, however, not a necessity; if each lamp is supplied with a short-circuiting cut-out, the failure of one or two in a circuit of 20 to 30 will only cause the current to rise to a small extent, and it is most exceptional for more than two lamps in 30 to fail simultaneously. Rather more choking is required in this system in order to prevent this possible rise becoming too high. A number of lamps are running on this system at Earl's Court. A direct-current transformer is considered necessary by some engineers, but the extra expense and lower efficiency seem to more than counterbalance any advantages.

Series enclosed alternating lamps are used to a considerable extent abroad, but up to the present have not found favor in England. A lamp has now been perfected which probably will have a large field. It is an alternating lamp arranged for running in series and has no cut-out and no dash pot. It has a specially designed choking coil in parallel with the arc, which, under normal conditions, take practically no energy, and only a small current, about 1 ampere; when, however, the arc is broken, the choker takes the whole of the current at the same voltage as before. The adjustment can be made so perfectly that the extinction of 50 per cent of the lamps in a series will not visibly affect the rest.

One more system of lighting remains to be discussed, that of the incandescent lamps. Unfortunately, where gas lighting is in existence electric incandescent lamps cannot compete on equal terms with incandescent gas. In several towns, Portsmouth and Hammersmith, for instance, incandescent lamps are fixed on the same posts as the arcs, and are automatically switched on when the arcs are switched off. The light is, it is true, sufficient after midnight, but the system is somewhat complicated, and complication is to be avoided wherever possible. The practice of switching off alternate lamps at midnight seems to be the sounder, from an engineering point of view, if the light is to be reduced at all. In entirely new districts, however, where no gas lamps exist, there should be a large field for electric incandescent lighting. There are on the market several types of lamps adapted to street use which give a very good effect. Two 10-cp lamps on each post, placed at intervals of 50 yards, give sufficient light for an average side road, and it is, of course, for these roads, where arc lamps would be an extravagance, that incandescent lamps would be used.

They may either be connected just as a house service to a distributor, or, preferably, have a separate main laid in the same trench as the distributor and brought back to the nearest sub-station, or to the end of the street and a switch put in one of the lamp posts. This system is being adopted in some new districts in Croydon.

In conclusion, attention is drawn to the importance of foresight in laying out a system of public lighting. The cost of excavation is, as a rule, so heavy, amounting in most cases to more than the value of a single cable of the length of the trench, that if all the cables required for both private and public lighting can be laid together in one trench, a very large initial outlay will be saved, besides obviating the inconvenience to the public of opening the road more than once.

Considering how really frail and complicated a thing even the simplest of arc lamps is, and how small a defect will cause irregularity or extinction, there is cause for congratulation that arc lighting has earned public approval to the present extent, in that there is hardly a town of any importance that has not at least its principal streets lighted by its means.

Although we have not yet by any means reached finality, we have advanced far, and do not now have to supplement our electric lamps by gas kept in readiness. Where we still fall short of the ideal is in being unable to produce a lamp small enough and cheap enough to be used at very frequent intervals, so as to more nearly obtain the uniformity of illumination which we want.

Incandescent Lamp Development to the Year 1880—I.

BY EDWIN W. HAMMER.

TWENTY years, and a little more, have gone by since the scientific world was scandalized, and the commercial world put agape, by the announcement from Menlo Park of the production of a practical and efficient incandescent lamp. But the doubters of those days have long since been convinced, capital has proven itself courageous and an enormous new industry has been created. Now that the controlling lamp patents have expired and many corporations are engaged in making incandescent lamps—the Edison Lamp Works alone turning out over a million lamps each month—jealousies are almost entirely suppressed; a history of the lamp may, therefore, profitably be compiled, and in a manner free from that contentious spirit which, ten years ago, would have militated against an accurate presentation of the facts. The following notes are gathered from original records of sworn testimony in lamp litigations in this country and abroad, and decisions of courts in such cases; from patents, text-books, magazine and newspaper articles, and other similar sources. So far as practicable such sources of information have been indicated in connection with the text. While this method of treatment does not lend itself readily to narrative, it is believed to be the most satisfactory way of making this historical résumé.

To Sir Humphrey Davy is ascribed the distinction of having been the first to produce an electric arc and to have demonstrated the enormous heating power of battery currents. His experiments with the 2000-cell galvanic battery of the Royal Institution are justly celebrated and are described in full in the *Transactions* of the Institution, 1810.

STARR-KING, 1845.

But, while it was thus known for years that carbon and platinum, for example, could be raised to a white heat by electricity, the history of the incandescent lamp did not really begin until 1845, when a British patent for "Improvements in Obtaining Light by Electricity" was granted to Edward Augustin King. This invention was that of an American, J. W. Starr, of whom practically nothing is known, and for whom King acted. It is generally believed that Starr resided in England, but died prior to King's application, which resulted in patent No. 10,919 of 1845. In view of the relation this lamp bore to those of Lodyguine, Bouliguine, Konn, Sawyer-Man and others, a detailed description may well be given. The lamp itself is shown in Fig. 1 of this article, reproduced from King's patent, and the following may be considered a fair summary of the specification's description. King had two alternative forms of lamp; in one he proposed the use of wires of platinum or other metals; in the other he proposed using pieces of carbon. Regarding the carbon he says: "That form of carbon found on the interior of coal gas retorts, which have long been used, is well suited for this purpose, and may be worked into the form of either small pencils or thin plates by the aid of the saw and file." The carbon plates or pencils are to be enclosed in a Torricellian vacuum produced in a glass tube similar to those used for barometers, except that the upper end is enlarged into a cylindrical bulb, with a stout platinum wire sealed in at the top. The length of the tube, exclusive of the bulb, was to be about 30 inches; the tube is filled with mercury in the same manner as a barometer and then stood upright with its open end in a basin of mercury, the column of mercury in the tube falling until it is balanced by atmospheric pressure, leaving a vacuum above it. The stout platinum wire *d* of Fig. 1 is threaded at its lower end, and to this is screwed a frame formed of the metal forceps *f* and *g* and the connecting and insulating porcelain rod *i*, carrying a carbon pencil *c*. To the lower end of the frame is fixed a stout copper wire *n* which serves to introduce

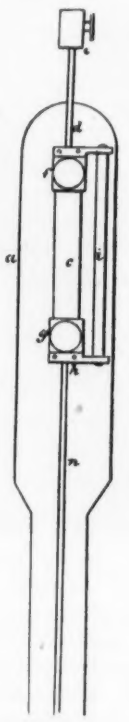


FIG. 1.

the frame up through the barometer tube and screw it to the platinum *d* before the vacuum is formed.

We thus have a construction described which was evidently never built by either Starr or King, and for obvious reasons. At the date of this patent, and for twenty years more, it was not known how to hermetically seal a "stout platinum wire" into glass and the boiling of the mercury in the tube to expel the air would have destroyed the copper wire *n* by amalgamation. According to Saywer, in his work on "Electric Lighting," "the Starr-King lamp had failed, because there was present in the Torricellian vacuum the vapor of quicksilver due to heat, with which the carbon entered into chemical combination."

The incandescing burner formed "by the aid of the saw and file" was made from hard, mineral, gas-retort carbon, and was of very low resistance; it required considerable current to heat it, and when two or more lamps were to be used they could only be arranged in series, as the patentee shows. Very little was known in 1845 as to the art of producing carbon conductors and "the irregularity and brittleness of the material seem to have been an insuperable objection and drawback," leaving the problem of commercial electric lighting yet unsolved. (See "Electricity in Lighting," by Dr. Henry Morton, *Scribner's Mag.*, August, 1889, p. 176.)

ROBERTS, 1852.

British patent No. 14,198 of 1852, to Martyn John Roberts, marks the next step, which is principally in the direction of an improvement in the form of the receptacle for the burner. This lamp is shown in Fig. 2, reproduced from the patent. The glass globe *C* has its neck

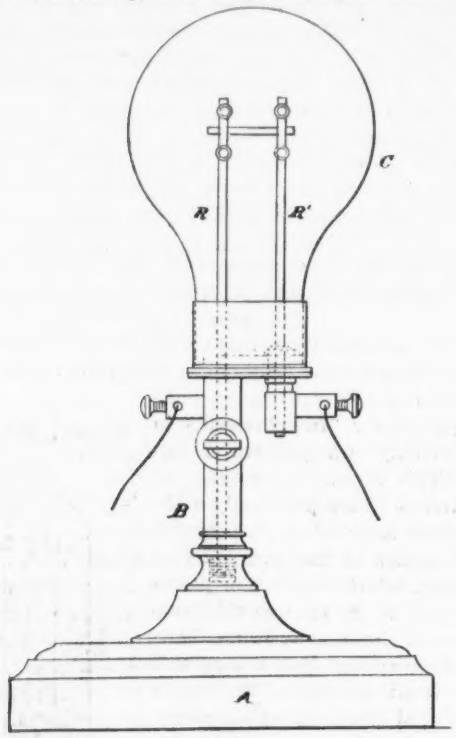


FIG. 2.

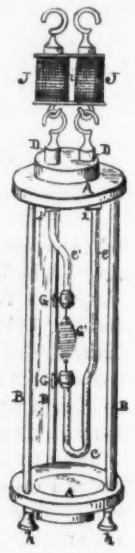


FIG. 3.

cemented into a metallic cap. The lamp is supported by a metallic tube *B* provided with a stop-cock, and the globe is exhausted through the pillar by an air-pump or exhausting syringe; after exhaustion the stop-cock is closed and the pillar is screwed into the base *A*. The burner *D* is "a thin piece of graphite, coke or charcoal, or other infusible body, being a conductor of electricity," and this is upheld by the metal rods *RR'* by suitable clamps. The inventor also says the burner may be "a piece of very thin graphite about half an inch long, half an inch wide and as thin as can conveniently be made." While this lamp was better, mechanically, than King's, it had the defects of the latter—low resistance, large radiating surface and inadaptability for use in multiple arc; it not being so well fitted as King's to preserve the vacuum, the life of its carbon would have been very brief.

This lamp apparently attracted no attention, as the various published histories of the art, up to 1880, make no mention of it.

DE CHANGY, 1856.

Belgian patent No. 3244 C, dated Aug. 28, 1856, was issued to Ch. de Changy, and is the only definite information we have regarding the inventor's lamp. Fig. 3 is reproduced from this patent, and shows the burner to be a cone-shaped spiral *G'* of platinum wire, heated to incandescence in a metal-ended glass cylinder; no vacuum is employed and the burner is protected by a supplementary external resistance *J*. Considerable prominence has been given to this lamp in the literature of the art, but this seems to have been entirely due to a highly eulogistic statement made to the French Academy of Sciences by M. Jobart, March 1, 1858. The Academy referred this report to M. Becquerel who, on April 5, reported that he had found nothing which would warrant an expression of opinion as to the value of the invention, and asked for fuller information; on April 19 M. Jobart responded that "he could not give more precise details without exposing the author, to see another profit by his discovery." (See *Comptes Rendus*, 1858, Vol. 46, p. 789.)

Numerous other experimenters, as Greener and Staite, Petrie, Draper, Farmer and others, had used similar applications of carbon and platinum, but without reaching any more practical results.

ADAMS, 1865-9.

Dr. Isaac Adams, residing at Gloucester, Mass., testified for the defendants in the suit of the Edison Electric Light Company vs. the United States Electric Lighting Company, on the Edison filament lamp patent, No. 223,898 (hereinafter referred to as the "Filament Record"), regarding his experiments with incandescent lamps. He was educated as a physician, but while abroad became interested in the manufacture of Geissler tubes, which he took up as a commercial undertaking upon his return to this country, in 1864. Being familiar with the properties of carbon, he, during 1865-6, made a number of lamps just as he had made his Geissler tubes, but with carbon burners about an inch to an inch and a quarter long, about three-sixteenths of an inch in width and from .005 to .01 of an inch thick; these carbons varied in resistance from .69 to 1.2 ohms, and were made by filing or scraping a block or strip of carbon as thin as he dared to, then dipping it in sugar and then reheating, making it tough and dense. The carbons were cut from gas-retort carbon, blocks of plumbago, carpenters' pencils or from a mixture of lampblack, powdered coke and molasses. Fig. 4 (from Filament Record, Vol. IV, p. 2691) shows how these lamps were made. *A* is a glass globe, *B* a carbon slip; *D D* copper or brass extension of platinum conductors; *P P* platinum conductors; *S* double sleeve of glass fused together and surrounding the platinum conductors; *J* joint of fused glass shutting out atmosphere.

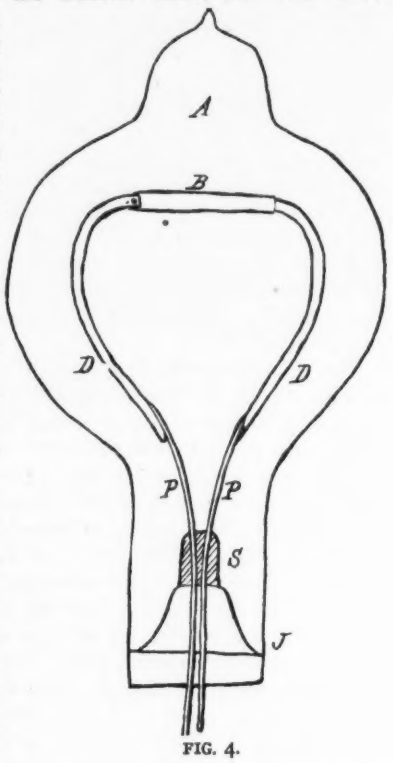


FIG. 4.

The vacuum employed was as perfect as Dr. Adams could make it with his improved mercury pump. Great difficulty was experienced by Dr. Adams in maintaining a vacuum because of the cracking of the glass around his large platinum leading-in wires (No. 16 B. W. G.), made necessary to carry the large current (from 11.5 amperes to 18.8 amperes) required by his carbons. This difficulty was not overcome until he produced a special character of glass from which to make his globes, having the same coefficient of expansion as the platinum. The question of dates was somewhat involved in Dr. Adams' mind when he testified, and it seems probable that no perfect globes were made before 1867. When cross-examined in the above case Dr. Adams said (Vol. IV, p. 2716):

"I had no idea at that time"—1867-9—"of having done anything of any special merit, as I thought the introduction of a piece of carbon into a globe to a person who was in the habit of making Geissler tubes was not much of a trick; but I was interested in the fact as to whether or not the big platinum that I put in the glass would hold, because I have always considered—did then, and do now—that I made an invention there which was a useful one. That was my interest in the lamp, and that was about all the interest I had in it. * * * Introducing platinum wires of relatively large cross section was the novelty."

This shows quite clearly what was the state of Dr. Adams' mind.

He did not make a practice of measuring the resistance of his lamps "because," he says, "I was not interested in that direction. I was not proposing to get up a system of lighting, not at all. I was simply making a lamp." He dropped the matter entirely in 1869. He had no records of the life of any of these experimental lamps and could only guess at the life of any one of them. It is perhaps unfortunate that Dr. Adams should have regarded his work from the standpoint of the glass-worker rather than that of the electrician, but the fact is that he had not advanced beyond the conceptions of King or Roberts, except so far as the enclosing globe and the leading-in wires were concerned, guaranteeing a better vacuum.

LODYGUINE, 1873.

M. Hyppolyte Fontaine, in his "Electric Lighting" (Paris, 1877; translated from the French by Dr. Paget Higgs and published in London, 1878) proves to be a most interesting historian in this art. He says (p. 171):

"Light by incandescence and the principle of its production, had for a long time fallen into oblivion, when in 1873 a Russian physicist, M. Lodyguine, resuscitated both, and invented a new lamp, which has since been perfected by Messrs. Konn and Bouliguine."

In 1874 the St. Petersburg Academy of Sciences awarded the Lomonossow prize of 50,000 roubles (about $38,500) to M. Lodyguine, upon the report of Dr. Wild, director of the Imperial Observatory. Describing this lamp, Fontaine says (p. 173):

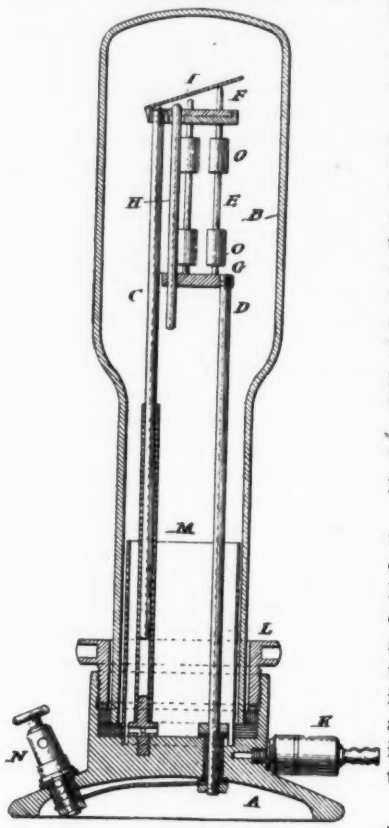


FIG. 5.

"In his lamp, M. Lodyguine employs carbon in a single piece by diminishing the section at the point of the luminous focus, and he places two carbons in the same apparatus with a small exterior commutator, in order to pass the current into the second carbon, when the first has been consumed. Nothing is less practical or less studied than the apparatus of this inventor."

Dr. Wild is quoted by Fontaine as having said in his report:

"Besides, the resistance of the carbon in question, as a conductor of electricity, is nearly 250 times greater than that of platinum; it results that the small rod of carbon may be fifteen times thicker than a platinum bar of the same length, and that the current traversing it will engender the same quantity of heat."

It is thus seen that rods of carbon of low resistance and large radiating surface were still the ideals of all inventors or experimenters in this field, and that provision was still made for renewing destroyed burners. An atmosphere of nitrogen gas was first employed, but subsequently this was replaced by a vacuum, more or less perfect.

KONN, 1875.

In 1875, M. Konn, also from St. Petersburg, patented an improvement of the Lodyguine lamp, which is illustrated in Fig. 5, reproduced from Fontaine's book. This lamp consisted of a glass tube *B*, enlarged and enclosed at the upper end, the lower open end being fitted upon a metallic base, *A*, provided with packing, *L*, and a valved opening, *K*. The two parallel vertical rods, *C D*, insulated from each other, support a frame in which are mounted five rods of carbon, *E*, arranged to be automatically brought into circuit successively. This is accomplished by the metal plate, *I*, hinged to the rod, *C*. Each carbon burner has a pin of different length at its upper end, the hinged plate resting on the tallest one, until the carbon to which it is attached burns out; thereupon the plate falls upon the next pin, bringing its carbon rod in circuit, and so on until the five carbons are consumed. Hard, dense carbons having low specific resistance, low total resistance and large radiating surface, were employed, and these were utilized in the imperfect vacuum which was all that was possible with the form of enclosure adopted for the globe. The idea was that the first carbon should, by its burning, transform the oxygen remaining in the globe into gases which would not support combustion, and that the subsequent carbons in burning would be surrounded by these innocuous gases. Fontaine describes some extensive experiments which he had made with the Konn lamps, and says (p. 179) regarding their life:

"The first carbon of a lamp never lasts for less time than a quarter of an hour; sometimes it breaks at the end of thirty to thirty-five minutes, but that is very rarely; its average duration is twenty-one minutes. The succeeding carbons last upon an average for two hours, so long as the luminous intensity does not exceed 40 burners, in which case the average duration is only half an hour. * * * From what precedes, it appears to result that King and Lodyguine's system is much more favorable to large foci than to the divisibility of the electric light."

Fontaine considered the repetition of his experiments, in connection with a Gramme machine, but was discouraged from doing so by the difficulty he had experienced in making the lamps burn; they presented too great difficulty in obtaining good contacts and too much delicacy and care were necessary at the beginning of each operation to secure any results.

Additions to the Montmorency Falls Transmission Plant.

In our issue of June 17, 1899, a detailed description appeared of the transmission plant at Montmorency Falls, Province of Quebec, as it then existed. At that time four 600-kw two-phase machines were installed, with provision for another machine, the pipe line having five branches entering the power house. A fifth unit has been installed since the publication of the above article, consisting of a Westinghouse double-current generator, otherwise a direct and alternating current two-phase machine, of 600-kw capacity at 286 r. p. m., the frequency being the same, of course, as that of the other machine—66 p. p. s.

The direct current side of this generator is used to supply current to an electric line running adjacent to the power house, feeding direct to the trolley wire where it passes the power house.

The alternating current side of the generator delivers current with a voltage of 400 to step-up transformers in the power house, which

FIG. I.—DOUBLE CURRENT MOTOR, MONTMORENCY FALLS PLANT.

increase the voltage to 11,000, and then transmitting direct to St. Ann de Beaupre, distant 15 miles. The step-down transformers there reduce the current to 400 volts, which runs a rotary converter feeding the trolley wire with a voltage of 550 at that end of the road. This railway system has also a feeder from the Quebec city end of the line, and in this way is maintained an almost uniform strength of current and speed of cars from end to end of the road.

This unit is provided with a switchboard consisting of six upright marble panels with the usual necessary number of meters and switches. The high potential transmission lines have three special automatic, combined, non-arcing, circuit-breaking switches. All of the electrical equipment and apparatus is protected effectively by the Wurts pyramidal form of lightning arresters with choke coils underneath. The arresters installed here are sufficient for a 15,000-volt

three wire alternating-current power transmission circuit, and can be used on any number of phases.

This plant is particularly interesting on account of the problems presented in designing a turbine suited to a high head of water, free from noise in operation and deterioration in a limited time from perforation of the metal exposed to the impingement of the water on the surfaces receiving the full force at a high pressure.

The turbines installed are the first of their kind in use, and are designated the "Victor high-pressure wheel," by the makers, the Stilwell-Bierce & Smith-Vaile Company. At the official test made by hydraulic and electrical engineers appointed by the Quebec Railway, Light & Power Company, the turbines at half-gate gave an efficiency of 78 per cent. As stated in the article previously referred to, the turbines make 286 r. p. m., and each of the five units has a capacity of 1000 horse-power under a head of water 260 ft. high.

The wheels when running are free from the noise of breaking water, jar and other detrimental qualities hitherto difficult to eliminate, which finally destroy the wheels by perforating the buckets, chute guides and other parts exposed to the impingement of the water. The wheel is also provided with an air chamber (situated between the wall and case) in which there is a float attached by a tube to an air valve (at the top of the air chamber) for admission of air to the

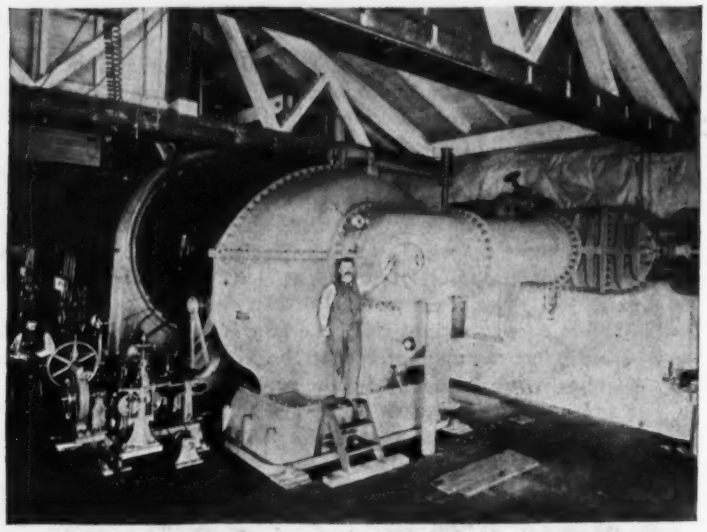


FIG. 2.—TURBINE DRIVING DOUBLE CURRENT GENERATOR.

wheel case and draft tube to maintain a partial vacuum in order to retain the water in case of a constant level below the wheel, irrespective of amount of gate opening.

Close by the wheel settings, and attached to each one of them, is a 36-in. gate valve, which is provided with a 6-in. by-pass pipe and valve, so as to enable the large valve to be opened easily, by equalizing the pressure on both sides, as otherwise they would have to be opened against a pressure of 36 tons.

For regulating variation of speed of the wheels and generators due to change of load, the Giesler mechanical electrical governor has been found to govern under the most adverse conditions the electrical load for railway, motor and lighting purposes. With a constantly varying change of load on the street railway circuit, the Giesler governor on this plant regulates the speed as shown by the tachometer within a 3 per cent variation (in 286 revs.), and on incandescent and arc lighting units the variation never exceeds 2 per cent. In the event of a line wire breaking or circuit breaker flying out, or any sudden removal of load, the governor will shut gate within the space of three seconds to a sufficient opening to keep the wheel running at normal speed.

An Experiment in Wireless Telephony.

A successful experiment in wireless telephony was made last Sunday by Mr. J. C. Kelsey, who has charge of the switchboard in the Northwestern Telephone Company's exchange at Minneapolis, Minn. As shown in the accompanying sketch, two No. 12 iron wires, 100 ft. in length, were laid on the ground on the opposite sides of a small lake, with the ends immersed in the water for a few feet. By means of two double-pole double-throw switches, an ordinary receiver, *R*, and transmitter, *T*, with transmitting battery could be successively thrown in circuit on each side of the lake. The sketch shows the apparatus in position for *B* to talk to *A*. When *B* is through talking he tells *A*, and they both throw their switches, which puts the apparatus in shape for *A* to send a message to *B*. Four volts were used in the transmitting circuit. It is proposed to make a more elaborate test over a lake one mile in width. A new signalling device will then also be tried.

There is nothing particularly new in the above experiment except, perhaps, using a fresh water lake as a conductor for the transmitting

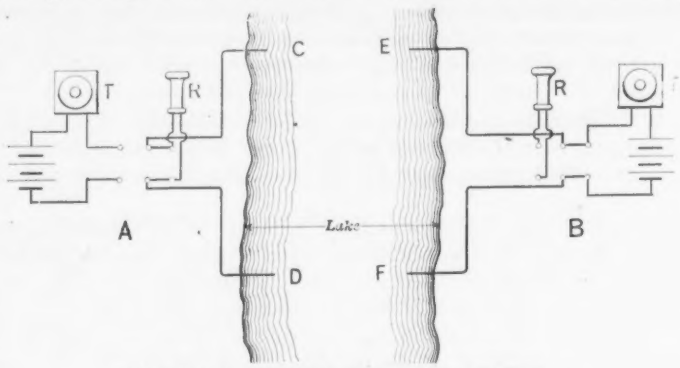


DIAGRAM OF WIRELESS TELEPHONE CIRCUITS.

current. As seen in the sketch, the transmitting current has two paths; one through the transmitting device and between *E* and *F*, and the other through the transmitting device on one side and the receiver on the other, crossing the lake between *C* and *E*, and *D* and *F*. The greater the distance *E F* and *C D* as compared with that of *C E* and *D F*, the greater will be the part of the transmitting current which passes through the receiver.

Train Telegraphy and Telephony in Japan.

The utilization of both the telegraph and telephone on the state railways of Japan has been quite rapid, and the development in this respect is equal to that occurring in the regular commercial service. The last annual report, received recently, has an interesting diagram of the different lines showing the various stations on the lines of the Imperial Government Railways, and enumerates the telegraph, telephone and block signal systems in detail. Altogether the 95 points on the railway were equipped, it would appear, as follows: Five had telegraph instruments only; 38 had telegraph and block signalling apparatus; 1 had block signalling only; 10 had telegraph, telephone and block signalling apparatus. Four of the stations were equipped only with telephones. One feature to note is that at 54 of the stations the Government accepted telegrams for transmission from the public. The total telegraphic traffic for the last year reported was 2,773,796 messages, of which 412,594 were from the public, the others being on service. It would appear that the total length of line of the Imperial Railways open up to March, 1899, was 718 miles; or 1010 miles of single track, the gauge of which is stated to be 3 ft. 6 ins.

The Franklin Fund.

The Franklin Fund, now amounting to $366,880, is the accumulation of a century's interest on $5,000 bequeathed to the city of Boston by Franklin, who provided in his will that at the end of a century the money should be used for public works. The one hundred years ended on Jan. 17, 1894, and although frequent attempts have since been made to dispose of the fund, it has been impossible to get the managers of the fund and the city government to agree as to how the money should be spent. Now a committee of the council, acting with the managers, has agreed to recommend that the money be used for the erection of a building, to be known as the Franklin Institute, which shall have quarters for a branch of the Public Library, and shall be devoted generally to the promotion of educational measures of two principal kinds, namely, those looking to general education; *e. g.*, by classes and lectures in history and in political and social science, and those looking to theoretical and practical instruction in such of the applied arts and sciences as are best calculated to stimulate and widen the intelligence, cultivate the taste, enhance the skill, and increase the efficiency of the people of Boston, special regard being given to those who are artisans. Seeing that there is a well-known Franklin Institute in Philadelphia, the choice of a duplicate name for the Boston institution is to be seriously deplored.

The Induction Motor—V.

BY B. A. BEHREND.

DESIGN OF A THREE-PHASE CURRENT MOTOR FOR 200 HORSE-POWER.

THE application to practice of the theory expounded in the preceding chapters will best be illustrated by a concrete case. To this end I propose to calculate a three-phase current motor for an output of 200 horse-power at 440 r. p. m. for a frequency of 60 ~. Voltage between the lines 2000. I have chosen a rather extraordinary case, the speed of 440 r. p. m. being comparatively low, while the frequency is unfavorably high, in order to show that it is yet possible to build a satisfactory motor for such conditions.

The following are further conditions for the design:

(1.) Normal output, 200 horse-power.

(2.) Maximum torque, 400 synchronous horse-power.

(3.) The motor must be able to start with the maximum torque.

The torque of a motor is measured in mkg. or foot-pounds. The product of the number of mkg. into the angular velocity of the rotor, divided by 76, yields the number of horse-power available at the shaft of the motor. The unit of horse-power used in America and England is slightly greater than the unit used on the Continent of Europe. To get "European horse-power," we should have to divide by 75. As, in a great many cases, we do not care much about the absolute value of the torque, we speak of torque *corresponding* to a certain number of horse-power at a certain speed. The most natural speed is offered us by the speed at synchronism. If we thus speak of a torque of 400 synchronous horse-power, this torque may be developed at any speed, but the product of it into the angular velocity of the rotor at synchronism is proportional to 400 horse-power. This very convenient mode of expressing torque in "synchronous horse-power" has been introduced by Mr. Steinmetz; at least the author first saw it some years ago in a short paper of this gentleman in the German *Elektrotechnische Zeitschrift.*

The motor must be wound for 16 poles, which gives a synchronous speed of 450 r. p. m.

The circumferential speed of the revolving armature should not exceed 7000 ft. p. m. A high speed is necessary in order to get a large pole-pitch upon which, as we have seen, the leakage factor is greatly dependent. So high a speed as this is not always favorable to a cheap, commercial design. Indeed, it may be urged that by choosing so high a speed as 7000 ft. p. m. we have overstepped the most favorable limit. Had I, in this article, set myself the task of designing a motor "poor and cheap," as the market may here and there require, I should have yielded to this objection from economy and adopted a slower speed. It is still a much vexed question whether, in the long run, the greatest commercial economy is not identical with excellence of quality. I therefore prefer to make the motor as good as possible without giving undue regard to cheapness.

The motor receives a diameter of 150 cm, corresponding to a circumferential speed of 6960 ft. p. m.

The pole-pitch is equal to $\frac{150 \cdot \pi}{16} = 29.5$ cm.

The air-gap will be made equal to 0.15 cm.

The coefficient c in formula (12) may be estimated for the shape of the slots which we are going to adopt at 12; we then have for the leakage factor according to formula (12):

$$\sigma = 12 \cdot \frac{0.15}{29.5} = 0.061$$

With this leakage factor a maximum power factor of $cos\,\phi_0 = \frac{1}{2\sigma+1} = 0.89$ is attainable.

The motor will take from the mains a current of about 54 amperes per phase at an output of 200 horse-power.

In order to develop a maximum torque equal to 400 synchronous horse-power, the maximum ordinate or the radius of the semi-circle in the diagram must be equal to

$$\frac{400 \cdot 746}{\sqrt{3} \cdot 2000 \cdot 0.85} = 102 \text{ amperes,}$$

assuming the efficiency to be 85 per cent at this output. Hence follows that the diameter of the semi-circle must be equal to 200 amperes.

The no-load current i_0 can now immediately be calculated, if we remember that the quotient of it and the diameter of the semi-circle must be equal to $\sigma = 0.061$. We thus get

$$i_0 = 12 \text{ amperes.}$$

From formula (6) follows the number of conductors per pole and phase, if a value for B is assumed. We make B, the maximum induction in the air-gap, equal to 5600, and we have then

$$i_0 = 12 \text{ amperes.}$$
$$\triangle = 0.15 \text{ cm.}$$
$$B = 5600 \text{ c. g. s.}$$

Inserting these values into the formula

$$(6) \ldots\ldots\ldots\ldots\ldots i_0 = \frac{B \cdot 1.6 \triangle}{2\, n \sqrt{2}}$$

we get

$$n = 40$$

The total number of active conductors per phase, z, is equal to n multiplied by the number of poles. Thus we have

$$z = 16 \cdot 40 = 640$$

We can now calculate the number of lines of induction per pole with the help of formula (5). It is

$$(5) \ldots\ldots\ldots\ldots\ldots e = 2 \cdot 12 \cdot \sim \cdot z \cdot N \cdot 10^{-8}$$

$$e = \frac{2000}{\sqrt{3}} \text{ volts.}$$

$$\sim = 60$$

$$z = 640$$

Hence,

$$N = 1 \cdot 42 \cdot 10^6 \text{ c. g. s.}$$

We found in the second chapter that

$$N = \frac{7}{12} \cdot b \cdot t \cdot B,$$

where b is the width of the motor, and t the pole-pitch. This formula is correct only if the slots in the field and the armature are practically closed. As we intend to keep the slots in the field entirely open in order to be able to exchange the coils easily, N will be about 85 per cent smaller than according to the formula. By taking this into account, we find for

$$b = 17.0 \text{ cm.}$$

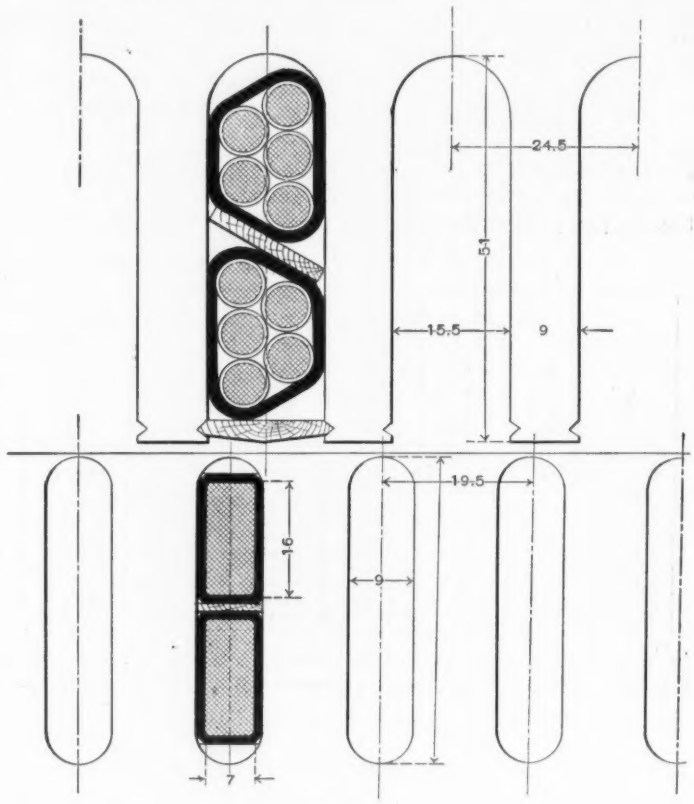


FIG. 22.

We leave in the middle of the iron a space of 1.0 cm for radial ventilation, so that the width of the iron becomes 18.0 cm.

The slots are represented in Fig. 22. The slots in the field are 2 ins. deep; in the armature 1⅝ ins. These slots represent about the largest size that should be used in polyphase motors. If possible, it is preferable to keep the slots smaller than those in Fig. 22. The

wire used for the field coils is No. 3 of B. & S. wire gauge, having a diameter of 0.229 in.

The maximum induction in the iron teeth is 13000.

The induction in the iron above the teeth should be no higher than 3000; this gives 15.0 cm of iron above the slots.

The main dimensions of the motor are inscribed in Fig. 23.

The resistance of each phase of the field is 0.28 ohm, hot.

The resistance of each phase of the armature is 0.016 ohm, hot.

The loss through hysteresis and eddy currents is 1100 watts, of which 530 watts is dissipated in the iron ring, and 570 watts in the teeth.

We are now in possession of all the necessary data to predetermine the behavior of the motor under load and at starting.

This has been done in the following table. After the explanation

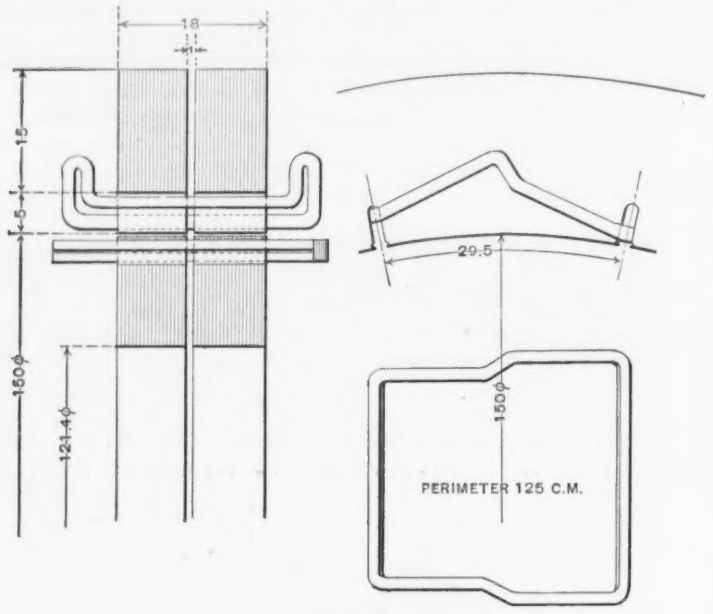


FIG. 23.

given in the preceding chapters, it would be superfluous here to enter upon the manner in which these figures were derived partly from Fig. 24, partly from the foregoing formulæ. A word, however, has

line and the curve which lies next to the semi-circle in Fig. 24, a measure for the torque and synchronous kilowatts available at the pulley of the motor.

For the calculation of the efficiency η I have assumed that the loss

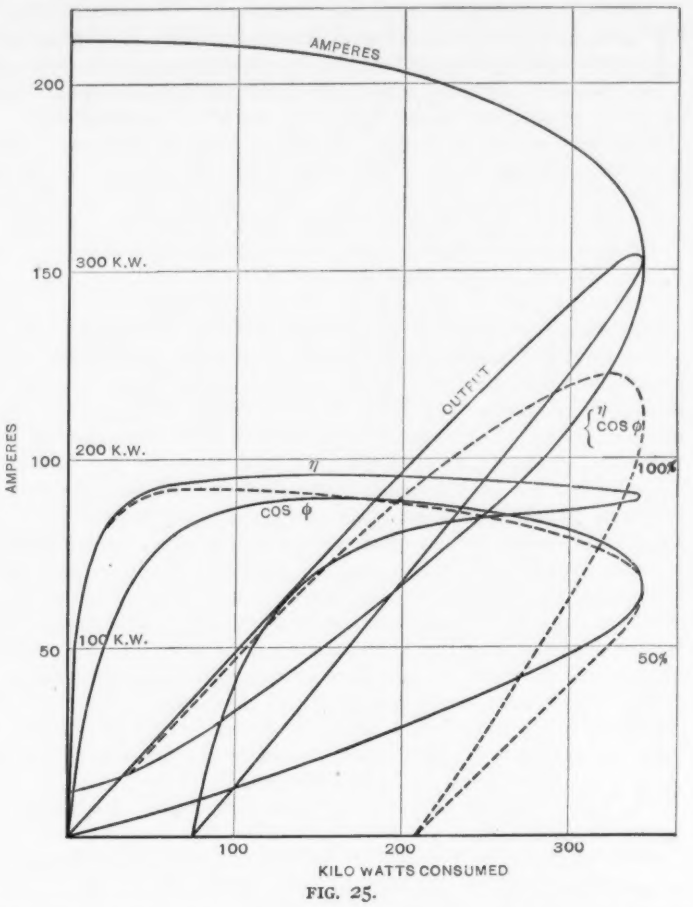


FIG. 25.

through friction and air resistance is practically constant at all speeds. That this is not accurately so, I need hardly remark.

The ordinates of the full line curve in Fig. 24 measure the output

Data of 200 h. p. Polyphase Motor for 2000 Volts, 60 Periods, 440 R. P. M.

Watts Input.	Amperes. Field.	Amperes. Armature.	Ohmic Loss in Field.	Ohmic Loss in Armature.	Watts Output.	Torque in Synchronous K.W.	Slip.	Efficiency η	Power Factor $\cos\phi$	Starting Resistance.	Ohmic Loss in Squirrel Cage Armature.	Watts Output.	Slip.	Efficiency η
52,600	20	60.5	336	175	48,790	48,965	0.0030	0.927	0.76	4.44	1,100	47,855	0.0225	0.91
124,000	40	148	1,350	1,050	118,300	119,350	0.0088	0.955	0.89	1.80	6,300	113,050	0.0528	0.911
159,000	51	193	2,190	1,790	151,720	153,410	0.0117	0.954	0.90	1.35	10,740	142,770	0.07	0.897
185,000	60	230	3,040	2,550	176,100	178,650	0.0143	0.952	0.89	1.11	15,350	163,300	0.086	0.882
240,000	80	307	5,400	4,530	226,770	231,300	0.0196	0.947	0.868	0.80	27,130	204,170	0.117	0.852
287,000	100	386	8,400	7,150	268,150	275,300	0.026	0.935	0.83	0.60	43,150	231,150	0.157	0.805
322,000	120	465	12,100	10,400	296,200	306,600	0.0333	0.920	0.78	0.459	62,400	244,200	0.203	0.76
343,000	140	545	16,500	14,300	309,000	323,300	0.0443	0.90	0.705	0.346	85,600	237,700	0.265	0.693
346,000	160	623	21,500	18,800	302,400	321,200	0.0585	0.875	0.623	0.260	112,800	208,400	0.351	0.603
315,000	180	700	27,300	23,600	260,800	284,400	0.083	0.828	0.505	0.178	141,600	141,800	0.497	0.45
325,000	200	780	33,600	29,300	158,800	188,100	0.156	0.705	0.325	0.07	175,300	12,800	0.93	0.057

to be said about the way in which the loss by friction is taken into account. With sufficient accuracy we may assume that the torque

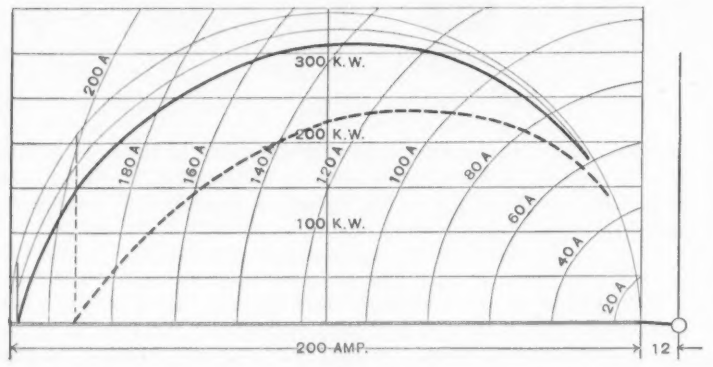


FIG. 24.

necessary to overcome the friction is constant at different speeds. By drawing a line parallel to the basis upon which the semi-circle is described, we find in the length of the ordinates lying between this

of the motor for an armature of small resistance, provided with external starting resistance.

The ordinates of the broken line curve measure the output of the motor having a squirrel-cage armature with considerable resistance—six times larger than that of the armature with external resistance—in order to start under load. A glance at the curves shows the tremendous reduction of the output with which we have to buy the advantage of dispensing with slide rings. This is even more conspicuous in the curves of Fig. 25. The abscissæ here represent the energy in kilowatts consumed by the motor, while the ordinates represent the field current, the output, the efficiency, and the power factor as functions of the energy consumed. As in Fig. 24, the full line curves represent the different quantities for the motor with external starting resistance, while the broken line curves show these quantities for the motor with squirrel-cage armature.

The field current, of course, remains unaltered, and so does the power factor. But the output, and therefore the efficiency, of the motor with squirrel-cage armature are powerfully influenced by the high resistance of the armature. For a starting torque equal to the torque at normal load, we need a current which is almost four times as large as the current at normal load; indeed, a poor result.

To emphasize this point once more, the abolition of an external starting resistance—either revolving with the armature, or placed outside the armature and being connected to it by means of slide rings—brings with it inevitably a considerable reduction of the output, and a lowering of the efficiency. The reduction of the output, as a glance at Figs. 24 and 25 shows, is equivalent to a reduction of the overloading capacity of the motor, diminishing the margin of power and thus tending to pull the motor out of step at a small temporary

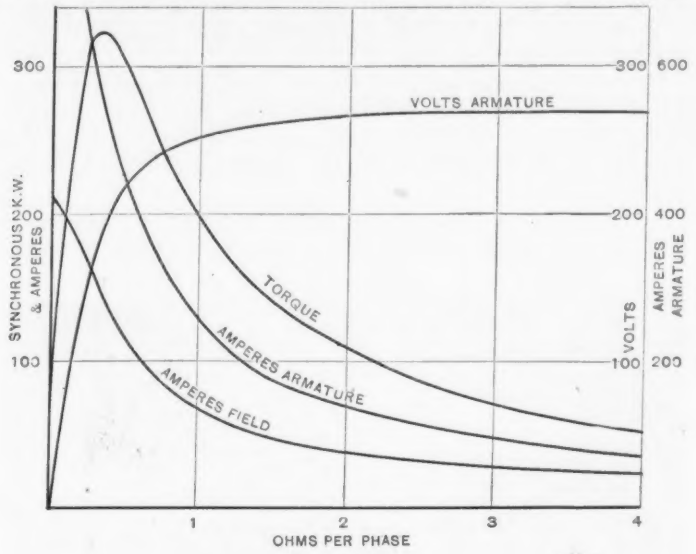


FIG. 26.

overload. For these reasons European designers have abandoned the squirrel-cage armature in all larger motors.

In the calculation of the efficiency the load losses have not been taken into account. As I have said before, they greatly influence the efficiency, but it is extremely difficult to predetermine them for various loads. Here is a field full of practical and theoretical interest which has been sadly neglected by investigators, but promises a rich harvest.

The Starting Resistance.—In order to calculate the resistances of the starting box, it is advisable to plot a curve representing the torque, and the amperes and the volts in the armature as a function of the resistance of the starting box.[6] This can easily be done if we remember that at starting for the same torque the energy available at the shaft of the motor, when running, must be dissipated into heat. We find, therefore, the starting resistance necessary to enable the same torque to be generated in the motor, by dividing the output by the square of the armature current. In this way the curve for the

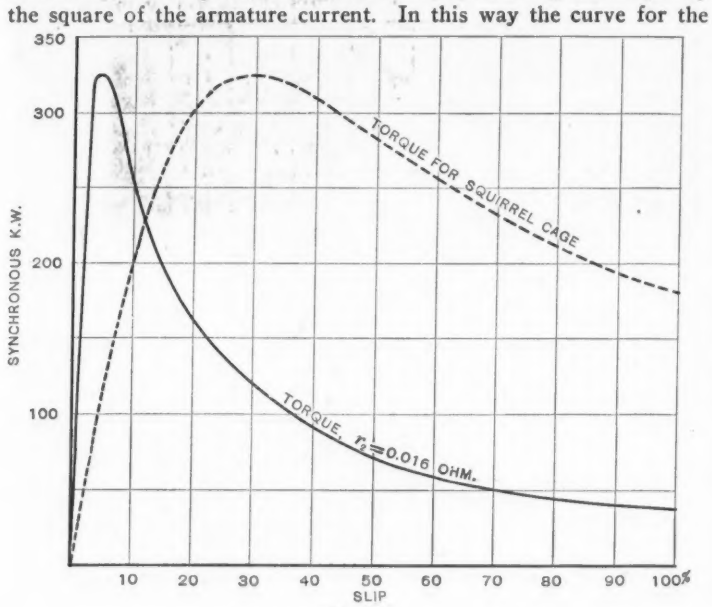


FIG. 27.

torque, in Fig. 26, has been drawn. From this curve we can find the starting current, the torque, and the voltage at the slide rings of the armature. The latter is considerable at a small starting torque, and the armature conductors must, therefore, be carefully insulated.

Slip and Torque.—Lastly, Fig. 27 represents the torque as a function of the slip. The curves demonstrate that the maximum torque attainable is entirely independent of the armature resistance. *The effect of a great armature resistance consists in shifting the same torque from a small slip to a large one.* Again, the full line curve gives the torque for the armature with a resistance of 0.016 ohm per phase, while the broken line curve shows the torque for the squirrel-cage armature having a resistance equivalent to six times that of the armature with external starting resistance.

Having thus finished the theory and calculation of the polyphase motor, it behooves us to glance back upon the comparatively easy road by which we have reached a complete solution of a problem which, if treated merely by mathematics, appears to be one of the most abstruse problems in natural philosophy. More and more we begin to realize the truth of the words with which Kelvin and Tait prefaced their lucid treatise on "Natural Philosophy," that "simplification of modes of proof is not merely an indication of advance in our knowledge of a subject, but is also the surest guarantee of readiness for farther progress."

Time was—and that not very long ago—when theories in which mathematical methods were restricted to a minimum, were glibly labeled "popular," with that fine flavor of contempt that hangs about this term. Slowly but surely graphical methods have supplanted, and will supplant in the future, highly analytical methods,[7] as in the graphical method the development of the idea can be followed stage by stage, thus furnishing a means of constantly checking the process of reasoning and keeping the attention of the mind concentrated upon the development of the thought. While a long analytical argument, after starting out from certain premises, leaves us in large measure in the dark until the result is reached. In my opinion the didactic value of graphic methods is vested in the difference traced out in the above comparison.

These remarks must not be misconstrued. In many cases the graphical treatment turns out to be far more complicated and wearisome than the analytical treatment, and I need hardly say that in such cases the latter is preferable. Whichever method is the simpler, in the case under consideration, deserves preference.

Export and Import Data.

It has already been noted that our exports show an increase of $166,331,178 in the 10 months ending with October 1900, as compared with the corresponding 10 months of 1899, and the total for the 10 months is practically double what it was in the corresponding months of 1894. This of itself shows a remarkable activity in all lines of production. The import as well as the export figures indicate that the activity in manufacturing lines, and consequently the increased earnings of the millions engaged in these industries must be very great. A very considerable share of the materials required for use in manufacturing comes from abroad, such, for instance, as india rubber, tin for use in manufacturing tin plate, hemp, jute, sisal, raw silk, cabinet and dyewoods, chemicals, etc., and by measuring the growth in the importation of these articles some idea of the growth in manufacturing may be obtained.

The total importation of materials of this class used in manufacturing during the 10 months ending with October, 1900, is $238,257,918, as compared with $214,396,757 in the corresponding months of 1899, and $127,301,945 in the same months of 1894. Turning again to the export side, it is found that the exportation of manufactures alone amounts in the 9 months ending with September, 1900, to $338,678,243, against $277,502,649 in the corresponding months of 1899, and $145,793,834 in the same months of 1895. Thus the exportation of manufactures has increased nearly 25 per cent in one year, and more than doubled in the four years from 1896 to 1900, while the importation of manufacturers' materials has also increased at a very rapid rate. Exports of manufactures of iron and steel alone amount of $110,000,000 in round numbers in the 10 months ending with October, 1900, against $86,000,000 in the corresponding months of 1899 and $51,000,000 in the corresponding months of 1897, thus having more than doubled in the three years from 1897 to 1900.

[6] This method was first recommended by Dr. Behn-Eschenburg, Oerlikon.

[7] One of the most complex problems in natural philosophy is the theory of the tides, on which the greatest mathematicians from the time of Newton until today have tried their powers. This is what one of the workers in this field, Prof. George Howard Darwin, himself one of the most powerful mathematicians of this age, reared in the very lap of mathematics, in Cambridge, England, says of graphic methods "In my paper on the 'Precession of a Viscous Spheroid,' I obtained the quartic equation from this last point of view only, and considered analytically and numerically its bearings on the history of the earth.

"Sir William Thomson, having read the paper, told me that he thought much light might be thrown on the general physical meaning of the equation, by a comparison of the equation of conservation of moment of momentum with the energy of the system for various configurations, and he suggested the appropriateness of geometrical illustration for the purpose of this comparison.

"The simplicity with which complicated mechanical interactions may be thus traced out geometrically to their results appears truly remarkable."

Electric Power in an English Colliery.

A MODERN electric power and lighting equipment has been installed and is now in active operation at the Sneyd colliery, Burslem, North Staffordshire, England. The colliery is situated about half a mile from the town of Burslem and is in rail communication with the North Staffordshire Railway.

There are three shafts into the mine in use at present and an additional one is being sunk. No. 1 shaft is used entirely as an upcast; No. 2 winds from a depth of 621 yards and recovers the Sneyd Main, Bowling Alley, Hollylane, Hardmine, Mossfield and Yard coal; No. 3 winds from a depth of 370 yards and recovers the Burnwood, Mossfield and Sevenfeet coal; No 4 is at present being sunk to work the Cockshead and Sevenfeet Banbury coal; its probable depth will be about 900 yards.

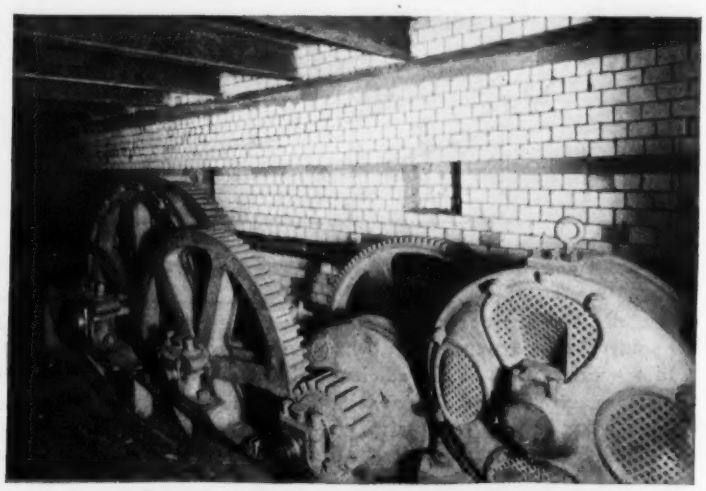
The workings are all arranged on the "Longwall" system with the exception of the thin seams, which are worked on a modification designed by the management and known as the "Spunney" system.

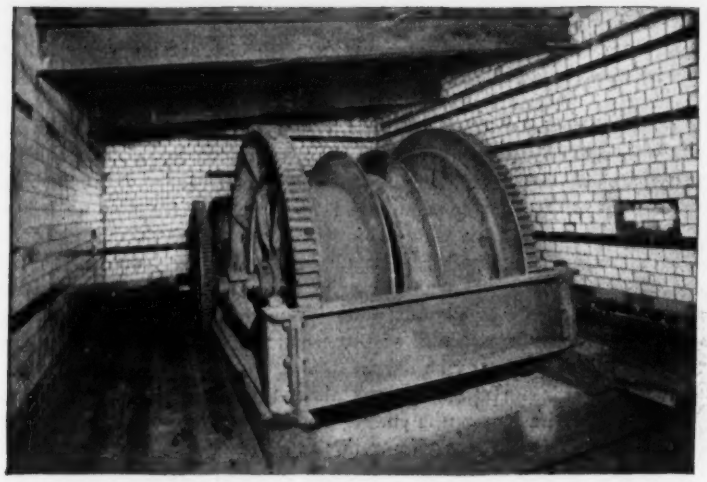
current, the remainder being supplied by a rectified current. A small transformer is located in the armature, in the secondary of which current is produced proportional to the armature current. This secondary current is rectified by commutators which are located at one end of the generator shaft and feeds the field. Thus, the generator becomes to a certain extent self-regulating for changes in load.

The power house switchboard is of white marble, 32 in. x 48 in. x 1½ in. thick, mounted on a wrought-iron frame at a short distance from the wall. The switches, instruments and fittings are of the usual Westinghouse patterns.

Paralleling arrangements are fitted in connection with the switchboard, for it is intended to add two similar generating sets to the power plant in the near future, and parallel running is to be adopted. The wiring of the power station is of paper-insulated, lead-covered cable.

The main power supply is distributed by means of triple-concentric, bitumen-insulated, lock-armored cables. Between the power





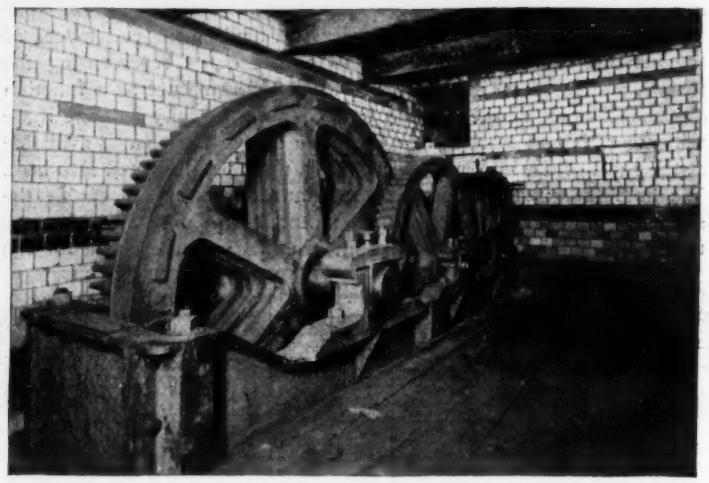


FIG. 1.—MAIN-AND-TAIL HAULING GEAR WITH INDUCTION MOTOR.
FIG. 2.—MAIN-AND-TAIL HAULING GEAR WITH INDUCTION MOTOR.
FIG. 3.—ENDLESS HAULING GEAR OPERATED BY AN INDUCTION MOTOR.
FIG. 4.—ENDLESS HAULING GEAR OPERATED BY AN INDUCTION MOTOR.

ELECTRIC POWER IN AN ENGLISH COLLIERY.

The measures all dip to the west with an inclination of about 25 per cent.

The mine, like most of the Staffordshire mines, is of a fiery nature, and safety lamps are used throughout; consequently it was considered essential that alternating-current motors should be used and that all switches, etc., should be actuated under oil. The order for the whole of the equipment was placed with the British Westinghouse Company.

The power house is built about 30 yards from No. 2 pit-head and contains a direct-coupled Westinghouse generating set, consisting of a 140-hp "Standard" engine and a 50-kw, three-phase generator running at a speed of 300 r. p. m., the steam pressure being 100 lbs. per square inch. The alternators are 10-pole, composite-wound, with a slotted core rotating armature. A small exciting machine, yielding 1.5 kilowatts at 125 volts pressure, provides the bulk of the exciting

house and No. 2 pit-head the cable, of which each conductor cross-section is 0.15 sq. in., is laid in a trench on the bitumen solid system. Down the shaft it is fixed to the walls by wrought-iron and wooden cleats secured by bolts. The main cable is jointed at 400 yds. depth and a branch main is thrown off into No. 3 pit. At the shaft bottom the main cable is teed to a similar cable of 0.06 sq. in. cross-section each conductor. One branch of this cable supplies power to a three-throw pump and a main-and-tail hauling gear; the other branch supplies power to an endless hauling gear.

Westinghouse Type C motors are used in the mines. The rotating part or rotor of these motors consists, as is well known, of a slotted, laminated iron core; heavy insulated copper bars are fixed in the slots, and are all bolted to, and short-circuited in, two heavy copper rings fixed one at each end of the rotor core. The fixed part or stator of the motor consists of a laminated iron hollow cylinder sur-

rounding the rotor, the primary windings being carried in slots on its inner surface. It will thus be seen how very suitable this type of motor is for coal-mining work. All windings are well protected from accidental damage; the absence of commutators or collectors gives immunity from fire or explosion, lessens the cost of attendance and maintenance; the motors are self-starting under full load, run with close speed regulation, have high efficiencies over big ranges of load and do not run away if the load be suddenly thrown off; moreover, they sustain no damage if sudden and excessive overloads be applied, even to the extent of a dead stop.

The three-throw pump, which has a capacity of 62 gallons per minute against a vertical head of 260 yards, is operated by a 30-hp motor.

Two views are given of the electrically operated main-and-tail hauling plant. This is fixed about 75 yards from the pit bottom, and is capable of hauling 40 loaded wagons at a speed of about 10 miles an hour. The distance covered by the hauling system is about 800 yards. A 20-hp motor, running at a speed of 720 r. p. m., operates the plant and is geared as shown.

The endless hauling gear is also geared to a 20-hp motor. It is installed about 120 yards from the pit bottom; the rope speed is about three miles an hour and the distance covered is about 1000 yards. It is calculated that these two hauling gears, which are capable of handling a total of 6000 tons of coal per week, represent a saving in labor of about 6 men and 10 horses.

Extensions are now in hand which will increase the capacity of the colliery plant to about 15,000 tons a week.

The manager of the Sneyd colliery, Mr. John Heath, is owner of the Globe colliery, Fenton, and electricity for power purposes is to be adopted there on similar lines to those followed in the Sneyd equipment.

The electric applications now in operation at the Sneyd colliery have proved to the owners that great economies are to be secured by this means; extensions are already in progress, and other collieries in different parts of the country have decided to follow suit, so that in a short time electrically operated collieries in England will not be the exception but the rule.

Latest Electric Train on the Manhattan Elevated.

A trial run of an experimental electrically operated train was made on the Manhattan Railway, New York, on Nov. 22. A section of the Second Avenue line, from Sixty-fourth Street to Ninety-third Street, had been bonded and equipped with third rails and the power was supplied through the courtesy of the Metropolitan Street Railway Company from its power station at Sixty-fifth Street and Third Avenue. The train consisted of six cars—two motor cars, one at either end, and four trailers. The weight of each motor car is about 35½ tons, and each trailer 14½ tons, making a total weight for the train of 129 tons, without passenger load.

The electrical equipment of the train consists of eight General Electric 55, 160-hp motors, four on each motor car, all controlled simultaneously through a hand-operated controller of the General Electric Company's design, type L-7. The controlling apparatus is located in a separate compartment at one end of each motor car. This compartment always faces the direction in which the train moves, and as it is entirely enclosed with glass the motorman has an unobstructed view of the line ahead. The controllers are of the same type as those used on the London underground and Baltimore tunnel roads, already described in these pages. The distinctive feature of the method of control is the removal of the reversing switches from the base of the controller and substituting electrically operated switches in each motor car. The movement of the reverse handle throws current onto both reversing switches at the same time, the current being carried through two small wires running the length of the train. A large cable, with necessary couplings between cars, is also provided through the train for supplying current to the rear motors. A separate cable for supplying current to the heaters and lights is also run through the train.

Rheostats sufficient for the operation of the eight motors are placed underneath the floor of each motor car, in the open air. In this exposed location they are kept cool by the rushing air caused by the motion of the train.

The entire current is taken from the shoes on the forward car and passes through a circuit breaker and thence to the main controller. With this method of control, the train accelerates at a uniform rate without any jolting. A view of one of the shoes is shown in one of the illustrations, which also gives a view of the operating compartment of one of the motor cars. The apparatus is of such design as to provide great strength to all the parts, and is of ample carrying capacity for the current used. The line voltage is about 550 volts and the maximum number of amperes taken during acceleration is about 1500. In order to avoid accidents to train hands and workmen, the third rail is encased in a wooden trough, the upper edges of which are slightly higher than the top of the rail, the space between the side pieces, however, being sufficient to freely admit the shoe. The train is equipped with air-brakes of the straight air type, furnished by the New York Air Brake Company. The air supply is obtained from motor-driven air compressors furnished by the General Electric Company. These are also in the operating compartment.

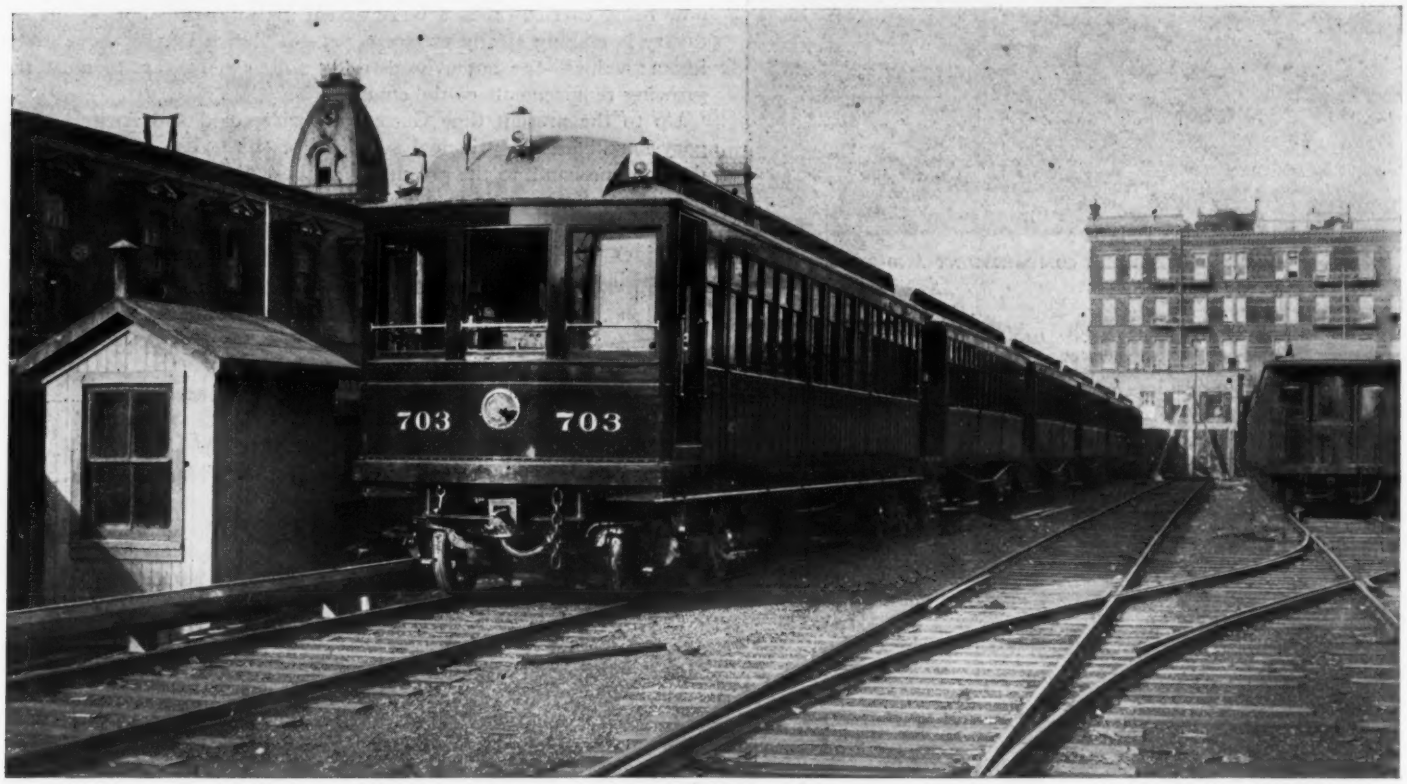


FIG. 1.—GENERAL VIEW OF MANHATTAN ELECTRIC TRAIN.

Complete tests will be made on the apparatus to determine accelera-

tion, speed and power consumption. The cars of the present experimental train are the same as the standard cars used on the road, but with some slight alterations. They are heated by electric heaters. In the new equipment, great improvement will be made in the appearance of the cars, which will be built higher and provision will be made for better lighting and ventilation. It is expected that a schedule of 14 miles per hour will be made with local trains on the Manhattan Railway after the introduction of electricity. The present speed, at rush hours, is 11 to 12 miles per hour.

The power station building at Seventy-fourth Street and East River, is under construction, and it is believed that the building itself will be completed within three or four months, after which time the machinery will be installed as soon as possible. Three of the seven sub-stations are also under construction, and their equipment will proceed simultaneously with that of the main power house. The new equipment will require at least 1600 motors of a nominal

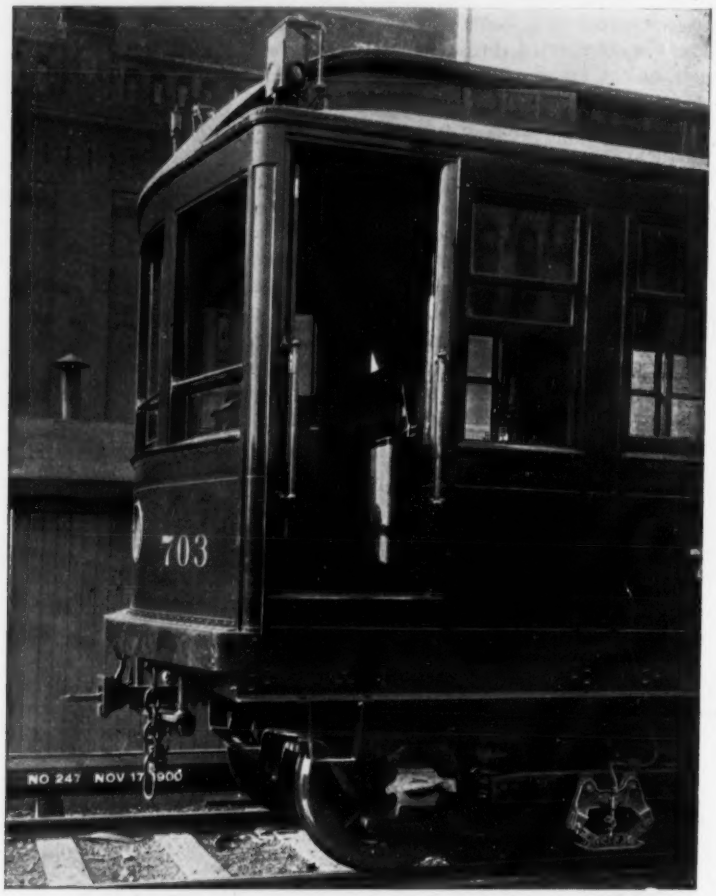


FIG. 2.—VIEW OF OPERATING COMPARTMENT AND SHOE.

rating of 100 horse-power each. Both the General Electric and Westinghouse Companies have built special motors to meet the requirements of the Manhattan service, and will furnish such motors for testing purposes before the contracts are let.

At the trial run a number of prominent railway men were present, including President H. H. Vreeland, Chief Engineer M. J. Starrett and Electrical Engineer W. A. Pearson, of the Metropolitan Street Railway Company; President Clinton R. Rossiter and Electrical Engineer R. P. Brown, of the Brooklyn Rapid Transit Company. The General Electric Company was represented by Mr. W. B. Potter, chief engineer of the railway department; Mr. Case and other engineers. Vice-President Alfred Skitt and General Superintendent W. E. Baker, of the Manhattan Railway Company, were also present. James S. Doyle, master mechanic of the electrical department, acted as motorman.

High Speed Engine Builders.

On Tuesday, December 4th, the association formed by the high speed engine builders of the United States will hold its annual meeting in the city of New York at Sherry's, Fifth Avenue and Forty-fourth Street. The afternoon session promises to be unusually interesting, as papers will be read on "The Relation between the Engine and Generator," by representatives of the General Electric Company and the Westinghouse Company, from the standpoints of lighting and power. Mr. Armstrong, who has given much attention to steam engine tests, will read a paper on "The Economy of the High Speed Engine." At this session builders of high speed engines, whether members of the association or not, will be welcome. A dinner, also at Sherry's, will be given the members at 7 o'clock. Mr. Thomas C. Wood is chairman of the council of the association.

Demand for Electrical Machinery in Italy.

BY H. L. GEISSEL.

THE Italian Government has granted a concession to the Mediterranean Railway Company for the construction of an electric railway from Sampierdarena, near Genoa, to Rome. A large and powerful electric central plant will be built for this purpose at Sampierdarena. It is further stated that the Mediterranean Railway Company will purchase 23 electric locomotives for this new line. Many other new enterprises are either contemplated or in course of construction throughout the whole of Italy. It is a well-known fact that there is a great scarcity of coal in that country, and there is little doubt that many of the railways now using steam as motive power will sooner or later be converted into those with electric traction. Italy was the first country on the Continent of Europe to build a standard gauge electric road—that between Monza and Milan—and the satisfactory results attained on that line are inducing other companies to seriously consider the introduction of electricity, especially on such sections which, by their situation, favor the adoption of electricity as motive power.

No doubt Italy offers a great market for all kinds of electric machinery and appliances, and American manufacturers should by all means make the most strenuous efforts to gain a firmer foothold on the Italian market. If it is considered that the imports of "electrical machinery" alone into Italy increased from 4,736,610 lire in 1898 (one lire, about 20 cents) to 9,037,720 lire in 1899, it will be apparent that the market is well worthy of our closest attention.

The northern provinces of Italy, and, in the first place, Piedmont and Lombardy, as well as Liguria and Veneto, abound in powerful mountain streams and waterfalls, which are awaiting utilization by electricity.

Though the manufacture of electrical machinery and appliances is now being carried on to a large extent in Italy, and though this industry is making steady progress, yet—as shown by the above given import values—the home industry is not able, by far, to meet the growing requirements of the country.

Up to the present time Germany, Switzerland and Austria-Hungary have been the principal suppliers of the Italian market, chiefly due, on one hand, to the proximity of these countries, but also to the persistent efforts made to get at the trade. We must also admit that certain Swiss, German and Austrian firms turn out excellent electrical machines which compare with any makes in the world.

Glancing over the details of the recently published Italian statistics we find that the trade was divided up as follows:

1. Imports of dynamo machines weighing more than 1000 kg.:

	1898.	1899.
Lire,	3,143,410	6,127,895
Of which from		
Switzerland	1,500,750	1,131,830
Germany	1,254,420	2,997,820
Austria-Hungary	239,430	1,739,720
Great Britain	80,040	39,100
United States	43,470	138,460
Belgium	22,310	22,310
France	2,990	58,650

2. Dynamo machines weighing less than 100 kg.:

	1898.	1899.
Lire,	1,049,800	1,997,230
Of which from		
Germany	419,100	1,307,900
United States	238,380	31,900
Austria-Hungary	166,750	281,300
Switzerland	116,580	335,820
Great Britain	29,870	4,350
France	6,670	16,240
Belgium	1,450	17,980

3. Storage Batteries:	1898.	1899.
	Lire, 19,500	54,150
Of which from		
Germany	..	47,700
Holland	9,600	..
France	8,400	1,500
Austria-Hungary	1,500	..
Great Britain	..	4,950

4. Parts of electric machinery:	1898.	1899.
	Lire, 550,900	758,450
Of which from		
Germany	157,150	222,250
Austria-Hungary	160,300	152,250
Switzerland	159,250	112,350
France	4,550	119,000
United States	54,600	90,300
Holland	..	36,050
Great Britain	15,050	26,250

Though not directly electrical, yet the following category may as well be classified together with the electric lines:

5. Hydraulic machinery, water and wind motors:	1898.	1899.
	Lire, 263,250	715,800
Of which from		
Germany	100,170	214,000
Great Britain	38,160	209,600
Austria-Hungary	31,680	257,000
Belgium	27,810	13,500
France	19,350	25,600
Switzerland	26,190	35,300
Tunis	19,350	..
United States	..	60,800

Thus it will be seen that Germany stands far and away at the top of the trade. To the total imports of electrical machinery into Italy in 1899 of 9,037,720 lire, Germany contributed 4,789,670 lire worth, or more than 50 per cent. Her trade increased from 1,930,840 lire in 1898 to 4,789,670 lire in 1899, an increase of 3,858,830 lire within twelve months. All the great German companies, such as the Siemens & Halske Co., the Allgemeine Elektricitätsgesellschaft, the Schuckert Company, etc., have their permanent agencies on the spot, generally in Milan, the commercial, industrial and financial metropolis of Italy.

Next comes Austria-Hungary, whose electrical machinery exports to Italy rose from 599,660 lire in 1898 to 2,430,270 lire in 1899. Of Austrian machines, the best known are those of the Ganz Company of Budapest.

Switzerland occupies the third place, though her exports show a decrease of 400,000 lire.

With these three countries the list of large suppliers of the Italian market is concluded. The United States takes the fourth place, but with the trifling amount of 321,460 lire, or a little over 3½ per cent of Italy's total imports of electrical machinery. Still less important is the share of France, Great Britain and Belgium, their combined exports amounting to about 5 per cent of the total imports.

In almost all the larger cities of Italy electricity is being more and more introduced, and new enterprises spring up almost constantly. That the demand for all kinds of electrical machinery is continuing to increase is best shown by the imports during the first eight months of the present year, when they amounted in value to 7,378,470 lire, as against 5,811,590 lire during the same period of the previous year.

With proper, energetic efforts, United States manufacturers should by all means be able to secure a larger share of the growing Italian trade than is at present the case.

The Thomson-Houston Mediterranean Electric Company.

This company, whose headquarters are at Brussels, Belgium, held its annual meeting on Sept. 29 last at Brussels, and from the interesting report just published we abstract the following:

The company was formed on Feb. 5, 1898, with the support of the French, American and German Thomson-Houston Companies, and with a capital stock of 5,000,000 francs. During the month of October of the same year, however, the capital had to be increased to 10,000,000 francs. The countries in which the Thomson-Houston system is now being exploited by the company are Italy, Spain, Portugal, Greece and Egypt.

A branch has been established at Milan, Italy, the business transactions of which have assumed large proportions. A large number of electrical engineers and administrative officials are in charge of that branch. The extensive works which are now under way of construction in Milan will enable the Milan branch to meet the numerous urgent demands for electric rolling stock and lighting appliances. The company owns the greater part of the Bologna tramways, and this company is now largely extending its network of electric roads. The Electric Tramway Company of Rome, also formed at the instance of the Italian Thomson-Houston Company, is now interested in various new electrical enterprises in Rome, and a contract has been concluded with the administration of the Mediterranean Railway Company to convert its line, Milan-Gallarate and branches, into electric traction for a length of more than 100 kilometers.

With regard to the Spanish business of the company, the report states that the volume of the company's trade in that country, too, is steadily growing in importance, and that especially at Valencia, Santander and Bilbao the company's undertakings are well under way. The report further on states that the increasing Spanish trade will doubtless necessitate the establishment of the company's own electric works in Spain.

The Hellenic Company, which was one of the first creations of the company, has greatly developed its sphere of activity, especially through the part taken in the matter of the tramways of Athens, the electrical installation of which has been secured for the company. Besides this enterprise, the company has been awarded several contracts for the installation of electric lighting plants in Greece.

As far as Egypt is concerned, the report continues, the company is about to send some experts over to that country to investigate electrical possibilities on a large scale.

The report concludes by asking the board of directors for in increase in the capital of the company, to enable it to carry out all the various enterprises in which it is now interested. An additional amount of 10,000,000 francs is asked for, thus increasing the capital stock to 20,000,000 francs. This proposal was agreed upon on the part of the administration at the recent meeting.

Surveys for the Pacific Cable.

One of the chief topics likely to be brought before the next Congress is the laying of the Pacific cable, and the matter is occupying no small amount of time on the part of the various government bureaux interested. In the annual report of Rear Admiral R. B. Bradford, Chief of the Bureau of Equipment, Navy Department, just made public, considerable space is devoted to the survey of the Pacific Ocean to determine the most feasible route for a telegraph cable connecting the United States with the Philippines. Submarine peaks and chasms were discovered by the surveyors. Last year the surveying ship Nero established the fact that a practicable cable could be laid across the Pacific. Later last year and this year surveys have been conducted to discover a practicable route between Guam and Yokohama, Japan, and from Dingala Bay, Island of Luzon, to Guam.

The zig-zag survey from Dingala Bay to Guam was completed on Sept. 7 last year. The Nero sailed from Guam on Sept. 9, and arrived at Yokohama on Sept. 24, having run a line of soundings at close intervals between the two ports along a route 1332 knots in length. After leaving Yokohama on Oct. 10, the Nero made a zigzag or traverse return survey to Guam, arriving there on Nov. 2. On Nov. 12, the zig-zag survey toward the United States was resumed. It was completed to the Midway Islands on Jan. 3, 1900, and to Honolulu, Jan. 29, 1900.

Mention was made in last year's report of an obstacle in the nature of a submarine abyss on the route between the Midway Islands and Guam, not far to the eastward of the latter. This abyss, which is the deepest yet discovered in the world, was then only known to be of a greater depth than 1900 fathoms. It now appears that, on the trip of the Nero to the westward, while attempting to sound, 4913 fathoms—or 29,478 ft.—of the sounding wire, all that was on the reel, were unwound without reaching bottom.

Upon leaving Guam, Nov. 19, 1899, on the trip to the eastward Lieutenant Commander Hodges made further explorations in this locality, now known as the Nero Deep, which confirmed the previously announced conclusion regarding the necessity for deflecting the cable route from the Midway Islands to Guam, and added to the knowledge of the greatly depressed area already referred to. This region, the extent of which the survey has well defined to the northeastward, afforded an opportunity for the Nero to make the two deepest casts and take the two deepest water temperatures ever recorded. The depths found were 5160 fathoms, and 5269 fathoms, and the temperatures were 35.6 degs. F. at 507 fathoms and 36 degs. at 5101 fathoms.

Heading Off Isolated Plants.

"Do you figure that it is cheaper for you to sell your exhaust steam for heating and run non-condensing than it would be to run condensing and not sell exhaust steam?" is a question recently asked of C. E. Roehl, superintendent of light and power for the St. Joseph (Mo.) Railway, Light, Heat & Power Company. This question was prompted by the fact that the company's station is directly on the Missouri River and could easily get condensing water. Mr. Roehl's answer to this question is an interesting one, and full of suggestion. The income from the exhaust heating part of the plant per year is just about equal to the coal that would probably be saved should the plant be run condensing. However, in St. Joseph there is another consideration. By undertaking a contract both to heat and to light buildings, the company can light many buildings which would otherwise have their own boiler plant and which, having their own boilers, would in many cases add engines and dynamos and do their own lighting. By thus offering both heat and light service, the company has secured the business of several buildings which originally had plans drawn for isolated steam and electric plants. Although the steam business alone may not show much profit over condensing, it is a valuable aid to the lighting end of the business, and at least pays for itself outside of that. During the summer months the engines in this company's plant will hereafter be run condensing.

Combined Circuit Breaker and Switch.

In a patent issued Nov. 13 to B. Parks Rucker, of Philadelphia, Pa., a circuit breaker combination is described, having for its object the control of the amount of current used by flat rate customers of electric light and power stations. In many parts of our country, notably in the South and West, flat rates are still in vogue, but the station manager has no sure method of preventing a customer from using, say, 20 lights when he only pays for 15. The unreliable nature of a metal fuse rendered its use objectionable to control the maximum current, and if the ordinary circuit breaker is used it can be tied down, or the calibration changed at will. In the circuit breaker patented, this latter defect is corrected.

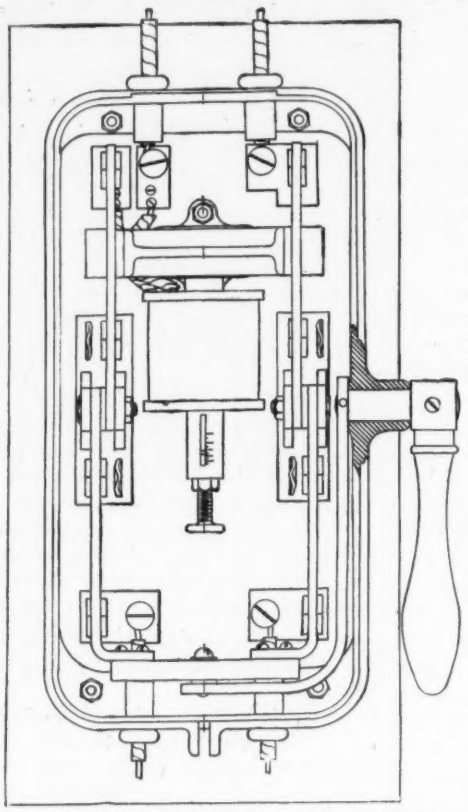


DIAGRAM OF CIRCUIT BREAKER AND SWITCH.

As shown in the accompanying illustration the circuit breaker consists of two parts — an automatic overload break and a hand-operating switch. The automatic break swings in the path of a hand-switch, and the latter is operated from a handle outside of the casing as shown. When an overload occurs, the automatic breaker flies out and falls over the hand-switch. To close the circuit again, the handle shown at the right is pushed upwards, thus forcing the automatic breaker into place, but at the same time opening the circuit at another point. The handle is then returned to its former position and the circuit is closed. It is thus seen that the circuit can be closed every time it opens, but the breaker can never be fastened in or its calibration changed without removing the lid of the case which is kept locked or sealed.

The patent describes the application of the same principle to a combined switchboard circuit breaker and main switch. The breaker is of the ordinary type, but is made to fall over the hand-switch, and the same operation is gone through as in the case of the flat-rate type. The advantage claimed for this latter arrangement is that it is made almost impossible for the switchboard man to push in the breaker on an overload, as the switch must be returned to its place before the circuit is closed. Another advantage is that the combination occupies a less space than a separate circuit breaker and switch.

CURRENT NEWS AND NOTES.

THE NERNST LAMP IN GERMANY.—According to our German contemporary, *Elek. Rundschau,* the Allgemeine Elektricitäts Gesellschaft, the German owner of the Nernst patent, is sending out circulars announcing that the Nernst lamp is now ready for the market.

THE WIRELESS AT HONOLULU.—A special despatch from Honolulu says: Arthur Gray, an expert in the employ of Mr. Marconi, arrived here on the City of Pekin to put the wireless telegraphy system into operation between the Hawaiian Islands. He brought all of Marconi's latest appliances. He expresses himself as confident that the system can be made to operate successfully.

VALUE OF ELECTRICAL PROPERTIES IN OHIO.—The report of the Ohio Secretary of State for the year ending Nov. 1, shows large increases in the value of electrical properties in that State. In new street railways the capital involved aggregates $10,352,000; capital increased $8,160,000; new electric light and power companies organized during the year, 14, with a total capital of $930,500; capital increased $254,000; new telephone and telegraph companies, 69. with capital of $1,388,999; capital increase $4,442,000.

THE MULTIPLEX TELESIG.—Messrs. W. S. Burnett and W. H. Goodhal, of Milwaukee, Wis., are the inventors of a device which permits the calling of any subscriber on a party telephone line without disturbing the other subscribers on the same line. The apparatus is called the multiplex telesig. It is stated that by the use of this selective system it is possible to maintain on one circuit telephone service, station signalling on railroads, police and fire signalling, messenger service, etc. In laying submarine mines any number of torpedoes can be placed in circuit and any one of them exploded without affecting any of the others. In hotel wiring it is stated that one circuit on this new system will take the place of the usual network of wires.

TO ENLARGE THE CHAMBLY PLANT.—The initial installation at the works of the Chambly Manufacturing Company, at Chambly, Que., from which point current is transmitted direct to the city of Montreal, 17 miles distant, consisted of four two-phase generators of 2000 kilowatts capacity each, wound to generate current at 12,000 volts. The plant was so designed, however, as to provide for the installation of eight machines of the same capacity. The demand for power has been so great that the Chambly Company has found it necessary to install the additional equipment originally provided for, and accordingly the four additional generators will be wound for 2200 volts, and by means of transformers the current will be stepped up to 12,000 volts for distribution over the circuits.

CHICAGO STREET RAILWAYS.—An ordinance introduced in the Chicago City Council provides for municipal ownership of street railways, through ownership or lease of all down-town lines. The feature of the bill is that it does not interfere with contracts between the city and the street railway company. It provides for the consent of the corporate authorities in all instances. It proposes to regulate the running time, transportation and the care of streets. It requires the consent of owners of a majority of the frontage in each mile of territory to be tapped, instead of a majority of the entire mileage to be covered. The city is to be given the reversionary right to purchase the road. The limit of franchise is twenty years. If the Council passes a franchise the ordinance will become valid in sixty days, unless a petition of 10 per cent of the voters is filed within thirty days of an election. If a petition is filed before the sixty days, and there is no election for months, the ordinance is to be suspended until the voters can decide if it ought to become a law. In case the city decides to operate a street railway, the issue of certificates of indebtedness must be referred to the voters. The City Council is to control the rate of compensation when a line is leased. Among other things, it requires the company to give a full statement of their affairs to the State Auditor.

GERMAN-ENGLISH CABLE.—The semi-official *Berliner Post* demands that the fifth cable between England and Germany, the funds for which were long ago raised, shall be laid immediately. The paper asserts that "enormous damage is resulting to German trade from the want of it."

"ELECTRIC BURGLARS."—A couple of men were recently arrested in California who are suspected of being "electric burglars," electrical apparatus having been found among their effects. A large outfit of electrical tools, wire cables, carbons, rubber gloves, etc., was found, cached under a sidewalk in Oakland, Calif., near the Bank of California. It is supposed these or other burglars had planned an attempt to rob the bank.

"ANTIENT LIGHTS."—The reproduction of "Patience" at the Savoy Theatre, London, after two decades has not only proved the wonderful vitality of the Gilbert and Sullivan productions, but has given rise to many reminiscences. It is instanced that when "Patience" was first produced at the Savoy electric light was used for the first time in a London theatre, and D'Oyly Carte had to give nightly assurances of the safety of the new illuminant.

OBJECTS TO TELEPHONES.—President Doherty, of the village of Bellwood, Ill., who impressed a posse and arrested nine telephone linemen who were attempting to string wires through the village a few days ago, declares that while he is president of the village Bellwood will be without telephones. He met three linemen and made the declaration, "They are no good, and we get along very well without them. After I am out of office telephone wires can be put up in any place, but there will be none in Bellwood while I am in office."

POPULAR SCIENCE.—In *Science* of Nov. 3 appears an interesting letter on the treatment of science in magazines and newspapers by sensational writers. As the initials signed to it are the same as those of one of the editors of this journal, and as one or two people have been misled by the coincidence, we hasten to say that the sentiments in the letter, which is excellent in some respects, are by no means wholly our own, especially where they reflect on Prof. S. F. B. Morse and on Mr. Nikola Tesla. The writer we take to be the president of an Eastern educational institution.

PARIS UNDERGROUND.—A heated discussion has been going on in the Paris newspapers because a court has fined the superintendent of the underground railway for allowing cars to be crowded beyond their seating capacity. The next offense means imprisonment. Since the opening of the Metropolitan subway American methods have been allowed to prevail and passengers have been taken on as long as they could jam into the trains. Now one-half of the public contends that this really modern way of overcrowding is better than delay, but the other half, which is not in a hurry to earn a living or get home from toil, makes a strong objection.

NERNST LAMP TERMINAL CONNECTION.—A patent was issued Nov. 13 to A. J. Wurts, relating to means whereby the glowers and heaters of Nernst lamps and their immediate supporting means may be readily detached from the stationary portion of the lamp by merely loosening some set-screws. For attaching the glower and heater terminal wires to their terminal rods or bars, contact plugs are employed, consisting of aluminum or other soft metal that is substantially non-oxidizable at the high temperature which obtains in the vicinity of the heaters and glowers of the Nernst lamp. A number of forms of such plugs are described.

STATE SUPERVISION IN ILLINOIS.—At a meeting of the Chicago City Council last week a bill for the creation of a State "Gas and Electric Light Commission" was presented, accompanied by a resolution requesting the Senate and House of Representatives to pass it. It provides that the Governor shall appoint a commission of three persons, who shall hold their offices two, four and six years, with salaries of $5,000 a year each. The board is given general supervision of all corporations engaged in the manufacture and sale of gas for lighting and fuel, or for electricity for lighting purposes. These companies are required to give to the board their financial condition on June 30 of each year, together with the dividends paid, a list of salaried officers and amount of authorized capital. On complaint of the mayor or trustees of any city, or of a customer of any company, the board is required to give a public hearing to the petitioners, and if the board deems proper, it may order the company to reduce the price of gas or electric light, or improve the quality.

WELDING ALUMINUM.—According to a German contemporary, W. C. Heraeus, of Hanau, has discovered a process for welding aluminum, based upon the discovery that aluminum will become soft at a certain temperature and that two pieces at this temperature by hammering may be joined together so integrally that all trace of the joint disappears. No oxide is formed on the metal at the welding temperature so that the weld can be made without any flux. It appears from the description given of the process that the critical temperature lies within narrow limits, and practice alone will enable one to determine when it is reached. In making a weld, the surfaces to be united are well cleaned and then lapped from ¼ in. to ½ in., depending upon the thickness of the metal. The ends are then heated by means of a blow pipe, and as soon as the metal has reached the proper degree of softness the two pieces are hammered together, the proper temperature being maintained until the pieces are intimately united.

TESTING HIGH VACUA.—A patent, granted Nov. 20, to John Waring, describes a method of gaging or measuring the degree of tension of a confined body of gas and with especial reference to obtaining an equal vacuum in the exhaustion of electric lamps. The fundamental principle underlying the method is that the regular transmission of heat in a rarified gaseous medium depends upon the density of that medium. In applying the invention a known resistance is taken as a standard, and with this is compared a resistance enclosed in a suitable chamber connected to the lamp bulbs or other chambers undergoing exhaustion. This comparison can best be made by using for the standard resistance one or more standard incandescent lamps and comparing therewith one or more similar lamps whose bulbs are in connection with the exhaust pipe to which the lamps are connected for exhaustion, a galvanometer being used to show the proper degree of vacuum. The theory of operation is that the deflection of the galvanometer is proportional to the change in resistance of the filament, which, in turn, is proportional to the change in temperature, and this, in turn, is proportional to the number of molecules impinging upon the filament, which number of molecules is proportional to the degree of vacuum; consequently, the deflection of the galvanometer is proportional to the vacuum. In other words, the method consists in electrically heating a conductor in a vacuum and measuring the electrical resistance of such conductor while heated. In carrying out the method, a Wheatstone bridge arrangement is employed.

MULTIPLE VOLTAGE CONTROLLER.—A patent was issued Nov. 20 to Gano S. Dunn, on a device which provides means by which a working motor may be connected to either of several conductors maintained at different voltages and regulated when so connected, the purpose being to enable the motor to be run efficiently at either one of several speeds. The apparatus consists of a controller by which the motor is started and a multiple voltage switch by which the motor armature is connected to conductors of the voltage requisite for the desired speed. Between the controller and the multiple voltage switch are interlocking devices by which the operation of the switch is prevented except when the controller is in the off-position, and which also prevents the movement of the controller from the open position when the multiple voltage switch is intermediate between any other points at which it makes connections. The interlocking device consists of a notched guide-slot for the switch lever, a movable plate on the opposite side of the lever from the guide-slot, a spring-pressed latch connected with the plate and a notched disk carried by the controller shaft. The controller consists of a cylinder with several groups of raised contact plates, and the multiple voltage switch is contained in a casing forming part of the controller casing. When the multiple voltage switch is to be set for a desired voltage by means of the guide-slot of the switch and the notched disk of the controller above referred to, the controller is locked and remains so until the multiple voltage switch has been set for the desired voltage, after which the controller can be moved in either direction as desired. By means of the guide-slot of the switch and in the notched disk carried by the controller, the switch is locked against movement from the voltage connection to which it may be connected whenever the controller is turned from the open position, and the controller is locked against movement from the open position while the switch is being shifted from one voltage connection to the other.

SNOQUALMIE FALLS.—By connecting up the circuits available, current in quantity for running motors has been transmitted from Snoqualmie with success a distance of 153 miles.

AN AUTOMATIC CATAFALQUE.—A very circumstantial story was published in the newspapers recently describing an electric catafalque, and there was an account of the grim sensation caused by its use in a New Brunswick, N. J., church, when, apparently, the dead took up its bier and moved toward the altar, to the consternation of the mourners. Investigation shows the story to be a fake, although as an effort of the imagination it is of no mean order.

CURRENT THEFT.—A wholesale haul of Chinamen accused of stealing current from the Edison mains has just been made in New York City. They are accused of having wedged the meters with cardboard so that the instruments would not act. When the inspector was expected the wedge was taken out. The saving is put at from $10 to $40 a month, part of which they gave to an American who taught them the trick. An inspector happened to go around at the wrong time and detected the trick. Nine or ten arrests have been made and the parties are out on bail. They assert their innocence and claim that they complained to the company of the smallness of their bills. That seems plausible and likely.

WIRELESS TELEGRAPHY.—A special dispatch from London says: The General Post Office is said to have taken over the Marconi system of wireless telegraphy. If this should prove so, nobody but the government will have the legal right to operate that method. The statement is not confirmed yet, but an expert commission of the Postal Department is preparing a report on the question of its adoption. Whether this will result in a revolution in telegraphy here, or is merely a governmental safeguard, remains to be seen. Under acts of Parliament the post office authorities have the monopoly of telegraphy throughout Great Britain and Ireland. They could prevent Mr. Marconi or anybody else from operating their own methods on business lines. Very probably the report now being prepared will be made the basis for offering a lump sum of public money for the wireless method. The Post Office Commission is negotiating with France and Belgium on the attitude to be adopted in the event of purchase.

SMOKE WHILE YOU TELEPHONE.—The following is from the New York *Times*: "While the returns were being received at Tammany Hall on election night," said one of the men who was there, "I saw something that I had never seen done before. A friend of Mr. Croker's sat at the telephone close to the 'boss' and received messages for the Tammany leader. In his mouth was a big black cigar, at which he was puffing vigorously. He received the returns, announced them to Mr. Croker, and asked such questions of the operator at the other end of the line as Mr. Croker suggested, never removing the cigar from his mouth, nor ceasing his puffing of smoke. It was a feat I had never before seen. It struck me as a rather difficult one, and I determined to try it. I made a thorough failure of it, and think others will who try the same operation. If you don't think it is difficult, try it once and see." While this may be so, and while many telephone battery box ledges will still be charred by cigars laid on them or littered with white ash, we believe that in Wall Street it is by no means an unusual thing to see a broker at the telephone in animated conversation with his cigar or cigarette still between his lips or teeth.

UTILITY OF SUBMARINE BOATS.—Mr. Thornycroft, the English torpedo boat builder, has been expressing some opinions on submarine boats. He does not believe it necessary for Great Britain to build boats of this type, even if the experiments of other nations have been quite successful. He is carefully studying the problem of devising a submarine destroyer, should it ever be necessary. Mr. Thornycroft regards the American submarine boat as the best type yet made, but he doubts its efficacy, even for harbor defense. "A shell dropped in the neighborhood of a submarine boat," said Mr. Thornycroft, "and exploded either level with or below it would afford sufficient shock to crumple up the boat. Possession of a submarine boat of your own will not help you to find an enemy's. They are at present of too limited range and insufficient propelling power to be really a serious factor, and the unsatisfied problem of keeping a level keel under water is yet to be solved. If I ever have to go under water with a submarine boat I shall prefer to sit outside." In spite of the opinions of Mr. Thornycroft, the British Admiralty has at last decided to give to the submarine boat, designed by J. E. Howard, of Tasmania, an official trial.

CHAUDIERE FALLS POWER.—The winter season at the Chaudiere Falls, Ottawa, promises to be an unusually active one. Large gangs of workmen will be at work in the reconstruction of large establishments which will replace and supplement those destroyed by the great fire last April. Operations are now in progress upon the site of the old Ottawa Electric Railway power house adjoining the new house which, being fireproof, passed safely through the fire. To prepare a suitable site for the new power house to be erected an excavation will be made in the solid rock 100 ft. long, 35 ft. wide and 10 ft. deep. A larger rock excavation 200 ft. long, 100 ft. wide and 35 ft. in depth has already been made on the site of the Ottawa Electric Company's arc light station on Head Street. A new power house is also being built there by the latter company. The Ottawa Investment Company has just completed a power house, built on the site of the Victoria foundry. About 3000 cubic yards of solid rock were removed to make room for the massive machinery installed by this company. The present building is only a temporary one, steel clad. Next spring a fireproof stone and brick structure will be erected. A large expenditure of money is being made in the improvement of the channels near the falls, with a view to increasing the water power. Rock islands are being blasted away and flumes and bulkheads are being rebuilt, or new ones constructed, in the channels through which the water passes to generate electric power for the Ottawa Electric Company, the Ottawa Investment Company and the Ottawa Electric Railway Company. New and improved water wheels will be placed in position for the purpose of obtaining greater power. It is expected that the completion of these improvements will place at the disposal of the several concerns over 20,000 horse-power. On a conservative estimate, it is stated that fully $1,200,000 will be invested in the various industrial works at the Chaudiere before the end of 1901. The Ottawa Electric Company has already let contracts for $150,000 worth of machinery, and will expend an equal sum on new buildings. The Electric Railway Company will also expend $300,000, while the Ottawa Investment Company is contemplating a heavy outlay upon its works.

SODIUM TUNGSTATE.—In a paper read for the Chicago Electrical Association by Mr. A. M. Blumenthal, and giving an excellent résumé of the subject of Roentgen rays, the following instructions are given for the preparation of sodium tungstate for fluorescing screens, with the statement that the substance can thus be easily made at a cost of about 40 cents per ounce. Two parts of sodium tungstate are mixed with one part of calcium chloride and the mixture introduced into a crucible. When heated for an hour or more in a good furnace the salts will fuse into a clear liquid, which, upon cooling, is chiseled out and put into water. The water dissolves out the sodium chloride which was formed, leaving the calcium tungstate in different sized crystals. As sodium chloride exerts active hydroscopic properties, thereby rendering the calcium tungstate quite negative to the Roentgen rays, it is important that the residue be washed until all traces of sodium chloride disappear. The author says he has had very good success in making this salt by heating the crucible in a good coal fire in the ordinary stove. These crystals are then powdered in an agate or porcelain mortar so that they will readily pass through an 80-mesh sieve, though for certain work the 120-mesh sieved crystals are preferable. The size of the crystals has considerable to do with the color of the fluorescence, varying from a pink in the larger sizes to a pale blue in the smaller crystals. Extremely fine ones do not give off fluorescence noticeable to the eye, but a photographic plate shows the presence of ultra-violet radiation. For mounting the crystals, the surface of a piece of cardboard is coated with a good white glue, starch paste or flexible collodion, and the crystals sifted on as evenly as possible, being careful to have all portions covered. After the adhesive substance dries the superfluous crystals are shaken off and the screen is ready for mounting in whatever way it is most suitable for the purpose intended. For examinations it is best to mount it at the bottom of the specially formed box, called a fluoroscope, designed so that it is perfectly dark inside, and allowing no artificial or daylight to leak in. Screens made with barium platinum cyanide or potassium platinum cyanide are much more desirable for fine definition and sharp detail, though very much more expensive, which as an item of first cost may not warrant the sacrifice of detail.

NEW CABLE BETWEEN NETHERLANDS AND ENGLAND.—Consul Listoe, of Rotterdam, under date of Oct. 23, 1900, sends the following: The laying of a third telegraph cable between the Netherlands and England, from Zandvoort to Lowestoft, was commenced on Oct. 8. The cable comprises four wires which will extend all the way from London to Rotterdam and Amsterdam. Telegraphing will be done by means of the Hughes apparatus, and at busy times with duplex Hughes. The cost of construction will be borne by both countries. The cable will greatly accelerate the telegraph traffic between the Netherlands and England and will also expedite the receipt of American cablegrams via London, as one of the wires will be immediately connected with the cables of the Anglo-American Telegraph Company at London, thus making cabling to the United States possible without the intervention of the London office.

CARBON BRUSH-HOLDER PATENT SUIT.—An opinion was handed down Nov. 8 by Justice Brandford, of the Circuit Court of the United States, for the District of New Jersey, relating to a suit between the Thomson-Houston Electric Company and the Walker Company, on certain improvements in brushes and brush-holders for dynamo-electric machines. The charge of infringement was based upon two patents, No. 394,999, granted Dec. 25, 1888, to Edwin W. Rice, Jr., and No. 462,973, granted Nov. 10, 1891, to Elihu Thomson and William O. Wakefield. These patents relate to a brush-holder and a brush of block form, spring-actuated and moving in a slot or socket of the brush-holder, the brush of the earlier patent being composed of copper strips or laminae, and that of the later patent of carbon and metal or of carbon alone. The brush involved is of the kind which bears upon the commutator in a direction not far removed from a right angle, and is kept in contact with it through the action of a spring or springs. The opinion holds that the claims of the Rice patent are infringed which cover a brush mechanism consisting of a main or primary spring acting upon a pivoted follower so mounted as to move independently of the brush-holder, and also employing an auxiliary or intermediate spring—under the combined influence of which two springs the motion of the brush in its holder or box is controlled and its end continuously kept in close contact with the surface of the commutator. The second patent relates to the employment of a brush pressing arm and a spring acting upon such arm so as to hold it upon either side of a dead centre. The mechanism consists of a brush carrying arm, a pivoted follower and a spring acting to hold the follower when swung to either side of a dead centre. In view of the prior art, the opinion holds that this device was wholly wanting in patentable novelty, and the bill was dismissed so far as it related to this patent.

RIGHTS OF AUTOMOBILE USERS.—The liability for frightening horses by the use of automobiles is a question which lately arose in the county court at Rochester, N. Y., and was decided by Judge Sutherland in an interesting opinion. A judgment of the municipal court in favor of the plaintiff, whose horse had been frightened by an automobile, was reversed, and the law of the subject declared as follows: "The horse has no paramount or exclusive right to the road, and the mere fact that a horse takes fright at some vehicle run by new and improved methods, and smashes things, does not give the injured party a cause of action. . . . If the defendant's motor carriage is practicable for the purpose of travel, and the noise and vapor caused by its use are kept within reasonable limitations, and are no greater than are fairly incident to the use of motor carriages which are found adapted to the needs of the general public, then I cannot see how the defendant can be held liable in the absence of evidence that at the particular time complained of the carriage was operated carelessly. . . . The temporary inconvenience and dangers incident to the introduction of these modern and practical modes of travel upon the highways must be subordinate to the larger and permanent benefits to the general public resulting from the adoption of improvements which science and inventive skill have perfected." A legal journal, *Case and Comment,* in commenting on this opinion, says it is unquestionably sound. There ought to be no doubt of the right, on the one hand, to adopt improved and valuable new methods of conveyance in the public streets, or of the necessity, on the other hand, of reasonable care to avoid damage in so doing. It is, of course, true that the rule of ordinary prudence requires extra care with respect to frightening horses on the part of one who takes a strange looking vehicle on the street, because the very fact of its strangeness makes an extra danger. When it becomes no longer strange, but common, the danger may become less, and therefore the degree of care and caution demanded may be for that reason proportionately less. An exercise of such care as the peculiar character combined with the strangeness of the vehicle demands ought, certainly to be a defense against liability for frightening horses by the use of any new conveyance that is of real public utility.

LETTERS TO THE EDITORS.

The Sticking of Relay Armatures.

To the Editors of Electrical World and Engineer:

SIRS:—In the article by Mr. W. O. Pennell, page 808 of Nov. 24 issue, the trouble mentioned in relay armature sticking is caused, I think, as follows: When the armature circuit is open the condenser is charged. Upon closing the armature circuit the condenser discharges through the contact points, and, being a circuit of very low resistance, a heavy current is sent through and fuses the contacts together. By inserting a resistance, as he shows, this prevents this rush of current and makes the condenser discharge more slowly. If the sticking were caused by electro-static attraction, the condenser would have no effect upon it.

THOS. W. VARLEY.

NEW YORK CITY.

Incandescent Lamp Measurements.

To the Editors of Electrical World and Engineer:

SIRS:—I have read with much interest the paper of Prof. Rowland on the rating of incandescent lamps by measurement of the light at the tip, and also the discussion of the paper by Mr. Elliott in a subsequent number. With your permission I will make some observations on this subject, to which I have given much thought.

It is somewhat difficult to consider the question academically, since Prof. Rowland has seen fit to bring the name of one company manufacturing incandescent lamps so prominently into his paper, somewhat against the custom of bodies of the dignity of the Franklin Institute, that this fact, taken in connection with the way in which the said company, in advertisements and circulars, is assuming the glory, such as it is, of the introduction of the double coil filament, makes his paper appear forensic rather than academical.

A reference to the cuts in the advertisements in your own columns would show that at least one other of the largest and best of the makers of incandescent lamps has been for a long time using the triple coil filament, without making any exaggerated claims about it, and certainly there are several other companies doing the same, so that the question ought to be considered on its merits, without regard to any particular manufacturers.

In fact, all makers of incandescent lamps would like to get rid of the anchor if they could well do so, for the simple reason that it adds about 1-10th of a cent to the cost of the lamp, which is not much, to be sure, but in these days of close competition it counts for something.

There are two reasons, however, which, I think, should prevent them from using the double coil, and abolishing the anchor. To make the best lamps, especially for the higher voltages, requires a long and slim filament, so long and slim that it is not quite stiff enough, without the anchor, especially in the 3.1 watt lamps. Uniformity of style is, of course, desirable, and so the 3.1 watt lamp sets the fashion for the others.

Secondly, it is plain that if by increasing the proportion of filament which looks directly downward, as in the double coil, and particularly in the flattened triple coil, which pleases its authors so much, the light thrown downward is very much increased, there must also be an equivalent amount of light from the other side of the filament, which is thrown directly upward, and so is practically entirely lost.

It is misleading for makers to claim in circulars that with a given amount of incandescent surface, as in a filament of a certain length and diameter, heated to a certain temperature, as indicated by watts per candle-power, a change in the shape of the filament can give more light downward, and still give just as much light horizontally, as is widely claimed by the advocates of this particular form of filament which pleases Prof. Rowland and Mr. Elliott so much. (See letter of the latter in your issue of Oct. 27: "In fact, the most exaggerated type of lamp of this sort, in which the filament is not only double coiled, but the coils flattened horizontally, so as to give the largest possible horizontal area of luminous surface, gives a vertical inten-

sity of 14.9 candle-power, with a horizontal intensity of 16.6 candle-power.")

Such a lamp, if the filament were of the ordinary form, would be at least a 20-cp lamp, and it uses current in proportion (which does not appear in the advertisements and circulars).

Now, as to the deductions of Prof. Rowland: They are based on two premises, which I desire most respectfully to traverse, at least for this part of the country. It is not a fact hereabouts that 95 per cent of incandescent lamps are mounted in a vertical position. Not 20 per cent of them are in that position. Excluding factories and the ceilings of a few large buildings, not 10 per cent are so mounted. His second and minor premise is that the lights, being vertical, it is desirable that the light be directed as nearly as possible downward. Here I beg leave to differ with him. Most people like as diffused an illumination as possible of the room in which they are. The notorious want of success of lamps having reflectors inside of the bulbs, except for special purposes, like the lighting of show windows, appears to me to be sufficient proof on this point. If we could suppose a lamp to have a perfectly straight filament it would give no appreciable light measured in the photometer from the tip, and yet it would make a most useful lamp, properly distributed in the customary positions in which our electric fixtures are made, and very little or none of the light would be wasted, by being thrown directly up into the base of the lamp.

On the other hand, such a straight filament, if transverse to the axis of the lamp, would give a great light from the tip, would waste a corresponding amount of light thrown directly upward into the base of the lamp, and would give horizontally a most uneven and unpleasant illumination.

Practically considered, all manufacturers would like very well to have a system of measurement in the photometer room which would obviate the necessity of rotating the lamp, such as would be the case if the measurement were from the tip. But neither makers nor consumers can afford the time to make and record various measurements, vertical, horizontal, mean spherical, downward, hemispherical and what not. Who could say what is the efficiency of a lamp in considering all these factors, except at a loss of time which would make incandescent lighting too expensive and annoying to be endured?

To sum up, the double coil filament is useful and advisable in 16-cp lamps for certain purposes, where the lamp must be vertical, and where either the voltage or the efficiency is low, and also for lamps of 32 candle-power, where it allows a smaller bulb to be used, and the filament is stiff enough to stand alone, without an anchor. For lamps of 16 candle-power or less of the best make and high efficiency, with voltage of 110 or over, it is not likely to be used by the most careful manufacturers.

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Boston, Mass.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

By CARL HERING.

Dynamos, Motors and Transformers.

Induction Motors as Generators.—Leblanc.—A continuation of

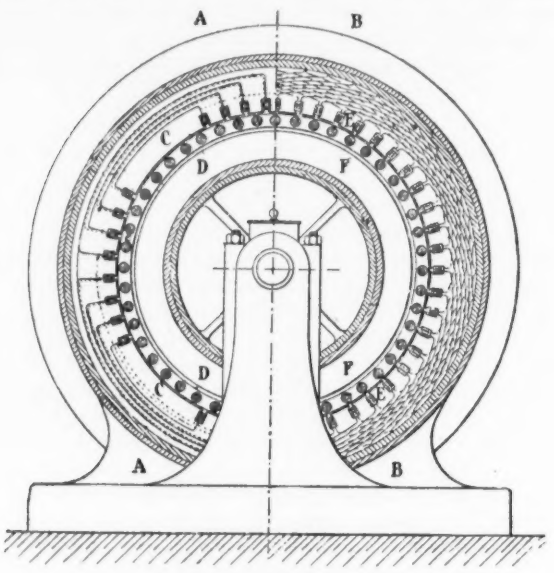


FIG. 1.

his long illustrated paper, noticed in the Digest Nov. 3. He describes a modification in the construction of an induction machine used as

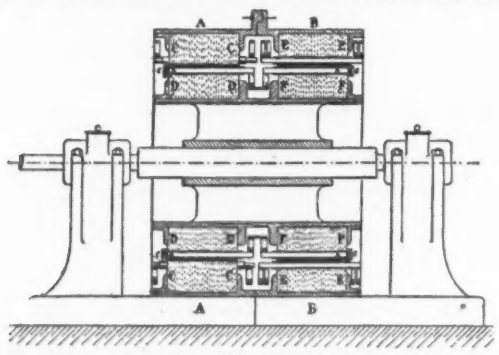


FIG. 2.

a generator, in which both the primary and secondary circuits are fixed and in which only intermediary circuits, closed on themselves, are moved. The arrangement is shown in the adjoining figures. There are two distinct machines, *A A*, *B B*, assembled on one base and around the same axle. The machine *A A* is composed (1) of a crown of fixed iron plates *C C*, carrying the primary winding of a single-phase induction motor, and (2) a movable crown of iron plates *D D;* close to the periphery of this crown are arranged the copper bars *b b*, insulated from the iron and regularly placed around the axis of the machine; the ends of these bars toward the outside of the system are secured electrically and mechanically by a circle of copper, *e e*, into which they are fitted; their other extremities are individually secured to the ends of the bars belonging to the movable crown of the machine *B B*. This second machine *B B* consists (1) of a crown of fixed iron plates *E E*, carrying either several identical circuits regularly displaced with reference to each other, or an armature winding like that of direct current machines, and (2) a movable crown of iron plates *F F;* the circuits carried by this crown are formed and arranged like those of the crown *D D;* it is important that the number of bars of which each is composed is the same. The connections between the ends toward the interior of the machine of the bars belonging to the two movable crowns, *D D* and *F F*, are described and shown diagrammatically. The whole arrangement is that *C C* is the primary, *D D* the secondary of the machine *A A; F F* is the primary, *E E* the secondary of the machine *B B;* the secondary circuits *D D* of the machine *A A* are not closed on themselves. but deliver alternating currents to *F F*. The generator, therefore, is a union, upon one base, and around the same axis, of two induction machines mounted in cascade. Such a machine requires for the same frequency of currents generated, a speed one-half that of an ordinary machine. He then begins to discuss the methods of artificially diminishing the coefficients of self-induction of the secondary circuits of an induction machine.—Lond. *Elec. Rev.*, Nov. 9.

REFERENCE.

Constant Potential Direct Current Converter.—Davies.—A reprint of the article abstracted in the Digest Nov. 10.—*Elec. Rev.*, Nov. 14.

Lights and Lighting.

Nernst Lamp.—A brief note, stating that the General Electric Co. of Berlin is now sending out circulars stating that the Nernst lamp is now being put on the market. (No further information is given in the note from which this is taken.)—*Elek. Rund.*, Nov. 1.

REFERENCES.

Reflector Lamps for Street Lighting.—An illustrated description of incandescent lamps, made by a British company for street light-

ing. The upper half of the bulb, shaped like a flat ellipsoid of revolution, is provided with a reflector which is a silver deposit protected against the action of the weather and mechanical injury by a coating of metallic copper deposited directly on the silver film. Diagrams are given, showing the distribution of light with such lamps.—Lond. *Elec.*, Nov. 9.

Progress in Electric Lamps.—BLONDEL.—A reprint of the English translation of his paper, noticed in the Digest Nov. 24.—*El'ty*, Nov. 21.

POWER.

Newfoundland Transmission Plant.—MARKILL.—An illustrated article on the water power plant at Petty Harbor, Newfoundland. There is at present one waterwheel, connected to two 600-kw three-phase generators, running at 327 revolutions and giving 500 volts at 60 p. p. s. Three 400-kw transformers raise the voltage to 15,000 for transmission to a sub-station in St. Johns. There are four 100-kw transformers for two rotary converters. The transformers are of connected Scott system, giving two-phase currents at 400 volts. There are also four 150-kw transformers, giving two-phase currents at 2040 volts, used for city circuits. The two 200-kw rotary converters run at 720 revolutions and give direct current at 500 volts for the St. Johns Electric Railway.—*Jour. of Elec.*, Oct.

REFERENCE.

Cableway for Trench Excavation.—An illustrated description of a cableway hoisting and conveying apparatus with traveling electric motor, used in New York City. The 15-hp motor is mounted directly on the traveling carriage. The operator rides on the carriage and controls the operations of hoisting, conveying, dumping and lowering by a system of switches.—*Eng. News*, Nov. 15.

TRACTION.

Schuckert Surface Contact System.—A well-illustrated description of this system, which has been in successful use on some tramway lines in Munich, Germany, since the summer of 1899. It is a single-row contact-stud system with grouped automatic switching apparatus, of which each, while separately switched into circuit, switches out the previous apparatus in the route traveled. The working of the relays is illustrated by a diagram and takes place in such a way that the advance relay in the direction traveled is excited, and closes the circuit immediately when its respective contact block is touched by the skate, while the draw-off coil of the surface contact, just passed by the collector, but still beneath the car, is energized by a shunt current of the advance apparatus, attacks the contact lever and switches out the section passed over. In case it should happen that a contact stud be left alive, there is a safety device which short circuits the section and opens the automatic cut-out as soon as the second stud ahead becomes live. The contact piece is a cast-steel stud let into a granite block which looks like an "ordinary paving sett," and is carried on a transverse iron sleeper. The contact studs protrude about 1⅛ ins. above the general surface of the roadway, and where curves do not require them to be put closer, they are about 13 ft. apart. The current collectors have the form of long steel wire brushes "or alternatively of chains of numerous linked disks." They are said to work excellently, even with heavy snow and mud, and to have the advantage of being silent; before and behind the collector comes a wide brush which puts the studs to earth through the rail; in general nothing happens as they are then dead, but if alive there would at once be a heavy short circuit which would open the automatic cut-out. The total cost of the installation is about twice that of an installation with overhead wires and steel poles, and scarcely one-third that of a slot conduit system.—*Lightning*, Nov. 8.

Nelson.—WILSON.—A brief article on the electric tramway of Nelson, B. C. Five hundred horse-power are furnished by the Kootenay Power & Light Co., of Rossland, and transmitted from the generating station at Bonnington Falls on the Kootenay River, a distance of 12 miles from Nelson. The three-phase currents are converted into direct current for the tramway by means of a motor generator.—*Jour. of Elec.*, Oct.

REFERENCES.

Burgdorf-Thun.—Continuation and conclusion of the long, illustrated article on this Swiss polyphase electric railway, the first part of which was noticed in the Digest Nov. 3.—Lond. *Elec. Rev.*, Oct. 19, Nov. 2, 9.

Exeter.—FAIRCHILD.—An illustrated article on the trolley lines between Exeter, Hampton and Amesbury.—*St. R'y Rev.*, Nov. 15.

Sydney.—WEBB.—The first part of an illustrated description of the electric tramways in Sydney, N. S. W. There are four steam-driven 850-kw generators and a storage battery of 600 cells.—Lond. *Elec. Rev.*, Nov. 9.

New England.—WALSH.—An article on the competition between electrical and steam railways in New England.—*West. Elec.*, Nov. 17.

Mining Locomotives.—PERKINS.—A brief illustrated description of several forms of electric mining locomotives, some centrally controlled, and others controlled from one end only.—*Sc. Amer.*, Nov. 17.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

REFERENCES.

Meters on Power Circuits.—PANAMOLO.—An illustrated article. He says that the installation of meters has the decided advantage of inducing to economy by users of motors. He gives illustrated descriptions of special tools needed in the making of alterations on meters, and gives hints showing how to make such alterations.—*West. Elec.*, Nov. 17.

Heating from Electric Stations.—ADAMS.—An article on the "heating value of exhaust steam at electric stations" and different plans for increasing the revenues of a station by selling heat from exhaust steam.—*Elec. Rev.*, Nov. 14.

WIRES, WIRING AND CONDUITS.

Cable Manufacturing.—WRIGHT.—An article referring to the paper of Mayer (Digest, Oct. 13, Nov. 10). He compares the English practice of cable manufacture with the American, as described by Maver. He refers to the statement of Maver that when the diameter of the conductor does not exceed 0.257 in. in diameter, the conductor is usually solid; that is, it consists of one wire; he says that indicates a lesser degree of flexibility than in use in England, where 0.08 in. in diameter is usually considered the limit when dealing with insulated conductors. The American method described by Maver for covering a conductor with rubber consists in passing the conductor through a machine similar to that used for gutta-percha work, i. e., the conductor, under moderate tension, is passed through the centre of a die which has a diameter equivalent to that of the covered conductor, the insulating material in a plastic state being forced out under pressure through the die and around the conductor. He says that this operation requires the insulating medium to be in a very plastic state and must therefore contain a smaller percentage of pure rubber, so that for this reason alone this operation is not used in England, where the alternative process has been adopted, which consists in passing the conductor, together with two strips or tapes of rubber, one above and the other below, between a pair of steel rolls, semi-circularly grooved to the finished diameter of the rubber-covered core; the peripheries of these rolls meet and form a cutting edge, which severs the excess of rubber at the point of completion of the insulating sheath, forming a longitudinal seam, which, depending upon the natural cohesion of freshly cut rubber surfaces, is a sufficiently perfect joint to withstand the strain of taping and ultimate vulcanization which secures it from parting. Another method adopted in England with the larger sizes of stranded conductors consists in "lapping" the rubber, in the form of tape, spirally around the conductor, each successive layer covering the seam in the preceding one. The object of the subsequent taping with a "proofed" tape, as adopted by English manufacturers, is to tempoarily bind the insulating material and thus secure the longitudinal seam from parting during the vulcanizing process. The tape also serves another purpose in that it prevents contiguous turns from adhering to one another by cohesion when wound on the drum previous to vulcanization. In exceptional cases no tape is specified and the rubber-covered core is then coiled into a receiver partially filled with French chalk, and while embedded in it, it is subjected to the vulcanizing process; the French chalk takes the place of the powdered talc or mica, through which, according to Maver, the core is drawn. He remarks that Maver does not mention the braiding process which is adopted by cable manufacturers to impart a finish, and to a limited extent, mechanical protection to the insulated core; this is the slowest stage of all, and necessitates the installment of a considerable plant to cope with the supply of core from the other departments of the factory.—Lond. *Elec. Rev.*, Nov. 9.

Loss Between Wires at High Tension.—An account of a test made "in the laboratories of one of the largest electrical manufacturing concerns in the East," to determine the energy loss which takes place in a transmission line of high pressure due to direct leakage through air from one line wire to the other. The results are given in tables. With a line of aluminum cable, of 0.9375 in. diameter, 13½ ft length,

a voltage of 50,000 and a distance of 12 ins. between the wires, the loss was 8 and 17 watts with frequencies of 50 and 133, respectively; with a distance of 24 ins. between the wires, the loss was 3 and 10 watts, respectively. With a line of copper wire, B. & S. No. 26, 11½ ft. length, a voltage of 50,000, and a distance of 8 ins. between the wires, the loss was 75 and 115 watts for frequencies of 50 and 133, respectively; with a distance of 18 ins. between the wires the loss was 27 and 60 watts, respectively. A second table gives the loss for a frequency of 60 and different kinds of bare and rubber insulated copper wire, of iron wire, and of aluminum cable, for different distances between the wires. A third table assumes poles of an aluminum cable line, to be set 120 ft. apart, a number of tie wires of No. 6 B. & S. copper wire placed on the line equivalent to the number per half mile and the loss measured; three cases are considered; first the tie wires point toward each other; second, the tie wires point away from each other; third, the same cable without tie wires or insulators, and supported by silk cord; the loss is the smallest in the third case; it is about four times and twice as large in the first and second case, respectively.—*Jour. of Elec.*, Oct.

Inductance of Concentric Cables.—EVERETT.—An article illustrated by diagrams in which he first considers a simple concentric cable, in which the outer conductor acts as a return for the inner; there is no outside field, but between the two conductors and also within the inner, there is a field due to the inner conductor. He gives a simple formula which shows that the smallest value of the inductance if a solid inner conductor is assumed, is 0.5, namely, when the dielectric is of negligible thickness; the inductance is the greater, the greater the ratio of the radius of the outer conductor to that of the inner conductor. The inductance is most noticeable in a cable of large section. The inductance of a concentric cable is practically in all cases less than that of a pair of separate cables. For a triple concentric cable for three-wire single-phase currents with the outer as the neutral, the inductance consists of three terms: First, 0.5; second, a term which is the greater the greater the ratio of the radius of the middle conductor to that of the inner conductor; third, a term which is the greater the greater the ratio of the radius of the middle conductor to that of the outer conductor. The field between the middle and the outer depends only on the difference of the two inner currents and the relative term of the inductance tends to reduce that difference. The effect takes place mainly on the current in the middle conductor, the inner being partly shielded by it. This effect tends to interfere with good balancing, but he shows in an example that it is almost inappreciable. He finally considers triple concentric cables, carrying three-phase currents; for a frequency of 50, and if each conductor has a section of 0.5 square inch, the voltage drop in the intermediate conductor may be increased 20 per cent or so, if its current is in advance of the inner current as regards phase, and, on the other hand, the drop is decreased if the phase relationship of the two currents is reversed; he thinks this point worth bearing in mind when connecting up the mains to the bus-bars.—Lond. *Elec. Rev.*, Nov. 9.

ELECTRO-PHYSICS AND MAGNETISM.

Ionization by Ultra-Violet Light.—LENARD.—An account of experiments in which he measured the velocity of ions produced by ultra-violet light. That of the negative ions he found to be 1.3 m. per second; with the e. m. f. used this gives 3.13 cm. per second for a potential gradient of 1 volt per centimeter. The corresponding value for the positive ions is 0.0015 cm. per second. Another conclusion is that "the sum of the radii of the molecule and positive electron" is about 70 times the diameter of a molecule; the positive electron must therefore consist of "a large number of atoms, even if it carries only one elementary charge."—*Ann. der Physik*, No. 10; abstracted in Lond. *Elec.*, Nov. 9.

Duffusion of Ions in Air.—TOWNSEND.—An account of the continuation of his researches on the rate of diffusion of ions under various circumstances. His latest investigations concern ions produced at various pressures by the action of a radio-active substance, and also determinations of the rate of diffusion of ions produced in air at atmospheric pressure by the action of ultra-violet light and point discharges. In every case the rate of diffusion of ions into a gas is inversely proportional to the pressure. The negative ions which are produced when the ultra-violet light falls on a zinc plate diffuse into air at nearly the same rate as the negative ions produced by a radio-active substance. The values of the coefficients of diffusion for dry and moist air are 0.0435 and 0.0375, respectively. The rates of diffusion of ions produced by a point discharge have coefficients varying between 0.021 and 0.039, being the highest for negative ions in moist air.—*Proc. Roy. Soc.*, Oct. 26; abstracted in Lond. *Elec.*, Nov. 9.

Positive and Negative Hall Effects.—VAN EVERDINGEN.—A paper on a novel effect obtained with a prism of bismuth cut from a block of the slowly cooled metal. A bar of bismuth cut at right angles to the principal crystallographic axis, when placed with this axis normal to the line of force, in a magnetic field of about 5000 c. g. s., shows a Hall effect of normal magnitude and normal negative sign; when placed with the principal axis parallel to the lines of force, it shows a small positive Hall effect. He does not think that the explanation of this effect presents great difficulties to the electron theory.—*Proc. Akademie Amsterdam*, Oct. 24; abstracted in Lond. *Elec.*, Nov. 9.

REFERENCES.

Alternating Currents.—GOLDSBOROUGH.—A continuation of his illustrated serial on "The theory of dynamo-electric mechanisms." He discusses Fourier's theorem and gives two numerical examples of the addition of several sine waves of equal or different periods.—*Elec. Rev.*, Nov. 14.

Diffraction in Roentgen Rays.—SOMMERFELD.—A theoretical investigation of the probable character of a diffraction phenomenon produced by a succession of irregular impulses such as Roentgen rays are at present thought to consist of. He obtains approximate results by the application of Huygen's principle.—*Phys. Zeit.*, Oct. 27; abstracted in Lond. *Elec.*, Nov. 9.

Energy of Becquerel Radiation.—RUTHERFORD and MCKLING.—An account of an investigation of the amount of energy involved in Becquerel rays. They have studied them in conjunction with Roentgen rays and compared the thermal and electrical effects produced by the two kinds of radiation. In radium the energy radiated per gramme of substance in one year is found to be not less than 3000 gram calories.—*Communication to Royal Soc'y*, a German translation in *Phys. Zeit.*, Oct. 27; abstracted in Lond. *Elec.*, Nov. 9.

Light and Electricity.—BICHAT and SWINGEDAUW.—A summary of the work of various investigators on actino-electric phenomena produced by violet rays.—*Sc. Amer.*, Nov. 17.

ELECTRO-CHEMISTRY AND BATTERIES.

The Ashcroft-Swinburne Zinc-Lead Sulphide Process.—A brief article on this process, which is to be used for the treatment of the mixed sulphide ore of the Tasmanian Copper Co. It is proposed "to mix the pulverized ore with fused zinc chloride and blow the chlorine gas through the mixture in a suitable vessel, like a copper converter." At a low red heat, it is claimed that the chlorine attacks the metallic sulphides with evolution of sulphur which can be recovered. It is necessary to keep the temperature below that at which the chlorides are volatile. The fused zinc and lead chlorides are to be decanted and subjected to electrolysis. It is proposed to continue charging ore into the fused chlorine in the converter until the accumulation of gangue in the latter makes the mass too thick for working.—*Eng. and Min. Jour.*, Nov. 17.

UNITS. MEASUREMENTS AND INSTRUMENTS.

Metastability of Cadmium Cell.—JAEGER and LINDECK.—A reply to Cohen's unfavorable criticism of the cadmium cell, noticed in the Digest Oct. 13. They acknowledge that the cadmium cell is untrustworthy at lower than ordinary temperatures, "though hardly up to 23 degs." They claim, however, that the Reichsanstalt cells maintain their e. m. f. within 0.01 per cent for years, and that 80 per cent of the 150 commercial cells tested maintain it within 0.02 per cent. As an additional precaution they recommend the use of a cadmium amalgam rather more dilute than 14.3 per cent.—*Ann. der Physik.*, No. 10; abstracted in Lond. *Elec.*, Nov. 9.

Astatic Wattmeter.—A brief illustrated description of an astatic wattmeter of Hartmann & Braun for direct and alternating currents. The relative position of the fixed and movable coils is chosen so as to make the wattmeter as independent as possible of terrestrial magnetism and magnetic fields in the neighborhood, and to avoid in alternating current measurements errors due to self-induction or to mutual induction between the fixed and the movable coils. Only one current coil, *S* in Fig. 1, is used, and is fixed. Two voltage coils are

used, S_1 and S_2, which are firmly connected together, but can turn around a vertical axle; when supplied with current they give fields of opposite direction, so that they represent an astatic system. The

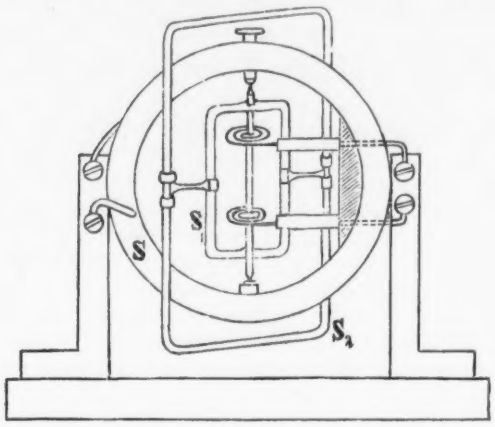


FIG. 1.

magnetic field of the earth and fields in the neighborhood act upon both coils in the same manner, while the field of S acts mainly upon S_1. This arrangement involves some difficulties in practical con-

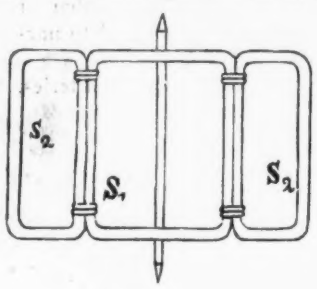


FIG. 2.

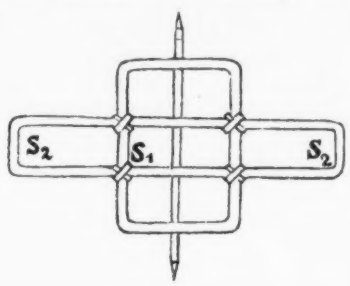


FIG. 3.

struction, which are avoided by the arrangements of the two voltage coils, shown in Figs. 2 and 3.—*Elek. Rund.*, Nov. 1.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Submarine Cable Speeds.—YOUNG.—An article giving a summary of the present status of theory and practice. The full theory of the propagation of waves along wires has been given by Heaviside. The condition of the "distortionless" circuit is that the ratio of the inductance and the resistance is equal to the product of the leakage resistance and the capacity; both sides of the equation have the dimension of time constants; for an ordinary submarine cable the ratio on the left hand of the equation has a magnitude of the order of thousandths of a second, while the product at the right hand has a magnitude of the order of minutes. To make both sides equal in order to get an ideal line, seems therefore practically hopeless; nevertheless, anything which tends to diminish the difference between both sides, is a step in the direction of raising the speed of signalling; this can be accomplished in four ways: By reducing the resistance, or by reducing the capacity, or by reducing the leakage resistance, or by increasing the inductance. The first two means are briefly discussed. Regarding the third means, the reduction of the leakage resistance, Heaviside has traced the influence of a single leak of different resistances at the centre of the line, by assuming the influence of inductance to be negligible, which can be done in the case of slow submarine cables. There are two effects caused by leakage; first, reduced damping of reversals at a given speed, due to the diminution of the distortion, which is a gain; and, second, reduced amplitude of the same, which is a loss; if, however, the first point is more exactly considered, it is found that very little increase of speed is to be derived from any arrangement of isolated leaks with siphon recorder signalling; only when a cable is going to be worked at a speed much below its maximum siphon recorder limit—as, for example, when relays are used—one or more leaks ought to prove of greater value, by increasing the sharpness of the impulses, and by discharging the line rapidly. In conclusion, the fourth means, increase of inductance, is discussed. He first considers a continuous increase of inductance along the line, which may be accomplished by making the conductor with a copper taping round it, or by iron sheathing. Breisig has found that by adding an iron ribbon to the core the improvement of signalling cannot exceed 8 per cent, when the limiting speed is about 150 letters per minute; if cables were capable of faster transmission the influence of the inductance would be greater, as it enters into the equations in the form of what is termed the reactance factor, which is the product of inductance and frequency. He concludes that not much is to be looked for from the naturally distributed inductance of the cable. Regarding an artificial, discontinuous distribution of inductance, he says that induction coils in shunt seem to be a failure, while induction coils in series appear to be the only remaining direction promising much improvement in cable telegraphy as far as the line is concerned. He says that Pupin's conclusions from his recent experiments are probably quite correct so far as the action of coils without iron is concerned, and that it now remains to be proved how far his predictions as to the action of coils containing iron can be carried out in an actual submarine line. For telephony a definite minimum total inductance per mile is necessary, but for telegraphic purposes any addition to it far short of this telephonic amount is conducive to gaining speed, provided the condition be observed of distributing it sufficiently to avoid the neutralization of its benefits by reflection.—Lond. *Elec.*, Nov. 9.

Hertzian Telegraphy with a Telephone Receiver.—An illustrated account of some experiments made by Guarini. In the first of them he had a telephone in a perfectly open circuit; one end of the telephone wire being connected to one side of an induction coil while the circuit of the primaries contained a telegraphic key; when Morse signals were sent by this key, they were received and interpreted easily by a listener at the telephone; he concludes that Hertzian currents produce magnetization of the telephone core as well as ordinary currents; and that telegraphy on a single wire, without earth or other return, is possible by means of Hertzian waves and a telephone. From a series of other experiments he concludes that the proper use of condensers in wireless telegraphy would lead to a great increase in the possible distance of signalling.—Lond. *Elec.*, Nov. 9.

REFERENCES.

Telephone Switchboards.—CLAUSEN.—A continuation of his long, illustrated serial (Digest, Nov. 10). He discusses, with the aid of diagrams, the fundamental means for communicating with the calling subscriber, and also establishing a communication with the called-for subscriber. He discusses at some length different forms of circuit-changing switches.—*Telephone Mag.*, Nov.

Metal Market.—Diagrams showing the fluctuations of the price of zinc, lead, iron, tin, copper, during the month of October.—Lond. *Elec. Rev.*, Nov. 9.

MISCELLANEOUS.

Luminous Electric Radiators.—A brief illustrated description of the latest pattern of Dowsing's radiator for heating rooms. The apparatus recommended as a substitute for a coal fire consists of a bright copper framework resembling an open fire-grate in appearance, in the bay of which are placed four incandescent lamps of special pattern. The "intensely reflected glow" from the stove is said to be very pleasant; when the reflecting sheets of copper themselves become heated, the current of air which passes behind them through specially arranged channels prevents backward radiation to the wall of the room and by flowing into the apartment, warms the atmosphere.—Lond. *Elec.*, *Elec. Eng.*, Nov. 9; *Lightning*, Nov. 8.

Nickel-Manganese Steel.—WILSON.—A brief paper giving an account of tests in which he studied the electric and magnetic properties and the tensile strength of Hadfield's nickel-manganese steel, which contains 25 per cent Ni, 5.04 Mn, 0.8 C. He concludes that this material, provided it does not seriously deteriorate by exposure to the air, is admirably suited for the construction of spiral resistance coils in which a high specific resistance is required. The specific resistance is nearly four and one-half times and the temperature coefficient a little more than double the corresponding figures for German silver. If heated with excessive current, the material, when again cool, is more ductile. Its specific resistance is practically unaltered, but this might not be the case with a large number of heatings and coolings.—Lond. *Elec.*, Nov. 9.

Prospect in South Africa.—A communicated article on "South African Orders," dealing especially with the question why most orders from South Africa are placed in the United States instead of England. The tyranny of the trade unions in Great Britain, which dictate the class of tools to be allowed and how much work a man shall turn out in a day, is said to be the reason the output of the British is being limited in comparison with that of the Americans, and also the reason why the Americans can underbid the British. For the fact

that most of the orders for the mining companies in South Africa go to the United States, the American mining engineers are blamed; they are very prominent there. Some remarks are made about "the dishonesty of certain American contractors," who, in accepting an order, "agree to do everything awkward and get out of it afterwards."—*Lightning*, Nov. 8.

Paris Exposition.—An illustrated description of machine exhibits of the Co. de l'Industrie Electrique de Genève.—*Revue de l'Elec.*, Oct. 31.

A brief article on the large searchlights on the tower of the German navigation section at the Exposition, and of another searchlight exhibited by the Schuckert Co.—Lond. *Elec. Eng.*, Nov. 9.

Durand.—An illustrated description of alternators exhibited by the Fives-Lille Co. and by the Helios Co.—*Elec. Rev.*, Nov. 14.

Fournier.—An article on the electric station of the Eiffel Tower.—*La Vie Scient.*; translated in *El'ty*, Nov. 21.

The eleventh article of the illustrated serial, describing inclined elevators and engines and dynamos exhibited by Belgian firms.—Lond. *Elec.*, Nov. 2.

A brief illustrated description of a 3000-hp steam-driven alternator of the Helios Company.—*Elek. Anz.*, Oct. 4.

Perkins.—An illustrated article on some French and Belgian machine exhibits.—*West. Elec.*, Nov. 17.

New Books.

THE PROGRESS OF INVENTION IN THE NINETEENTH CENTURY. By Edward W. Byrn, A.M. Munn & Company: 480 pages, large octavo, 300 illustrations. Price, $3.00.

Mr. Byrn has written an admirable book, which covers the great discoveries of the century, and sums up the growth of modern industries out of the useful inventions of the period. It is natural that electricity should occupy a large share of his attention, and several chapters are devoted to those branches of electrical application and engineering created during the past one hundred years, and utterly unknown before these latter days. The broad features of each evolution are delineated with considerable skill, and without wearying by insistence on detail, Mr. Byrn contrives to convey an amazing amount of useful information.

Not only is the book handsomely bound and well printed, but it brims over with illustrations. There is also a fairly good chronology. But fixing dates is always ticklish work, as Mr. Byrn realizes.

THE CONSTRUCTION OF LARGE INDUCTION COILS. A Workshop Handbook. By A. T. Hare, M. A. Methuen & Company, London: 155 pages, 35 illustrations. Price, $2.25.

This is intended as a guide to the ambitious amateur who likes to make his own apparatus. Mr. Hare began with Roentgen ray work, and soon set about building his own coils, learning the art by experimentation of his own very largely, for the manufacturers are not profuse in their instructions to the public on such esoteric points, and the philosophical literature of a practical nature is very scant.

The data are minute, and the diagrams are frequent, while Mr. Hare has availed himself of friendly expert aid on various parts of the subject. A coil giving a 13 in. or 14 in. spark can be obtained from a coil built upon the lines here laid down.

Directory of Electrical Societies, Etc.

CANADIAN ELECTRICAL ASSOCIATION. Next meeting, Ottawa, Ont., 1901.

CHICAGO ELECTRICAL ASSOCIATION. Next meeting, Dec. 7. Paper by C. Wirt.

LEAGUE OF AMERICAN MUNICIPALITIES. Next meeting, Charleston, S. C., Dec. 12-15.

ROENTGEN SOCIETY OF THE UNITED STATES. Next meeting, New York, Dec. 13.

UNDERWRITERS' NATIONAL ELECTRIC ASSOCIATION. Next meeting, New York, Dec. 11.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Next meeting, Niagara Falls, N. Y., September, 1901.

AMERICAN STREET RAILWAY ASSOCIATION. Next meeting, New York, October, 1901.

NORTHWESTERN ELECTRICAL ASSOCIATION. Next meeting, June, 1901.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Next meeting, New York, 1901.

A Magneto-Electric Telegraph System.

There is on exhibition at the New York office of the National Magneto-Electric Telegraph Company, in the Park Row Building, apparatus for the transmission of electric signals that is radically different in principle from anything in use at the present day. Briefly, the system consists in the use of induced currents generated in a magneto, transmitting them in the form of the Morse code or otherwise, and receiving them on a polarized relay.

The idea of using induced currents in telegraphy is not a new one, but in this instance the application of the principle by the creation of high potentials through the inductive effect gained by the sudden stopping of the armature reduces it to a practical basis and a much wider field of usefulness is suggested for the new system than was though of in connection with the earlier systems of magneto-electric telegraphs. In the early days of the telegraph in Europe Siemens & Halske developed a system of telegraphy operated by induced currents, the object evidently being to dispense with batteries. The method of operation was essentially similar in principle to that of the one under consideration, but its application was confined to narrower limits.

The principal feature of the system is the entire absence of batteries,

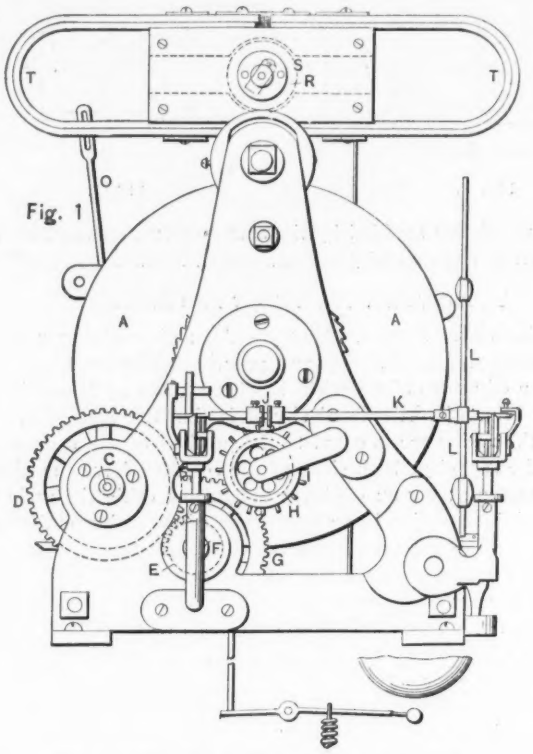


Fig. 1

FIG. I.—REAR VIEW OF FIRE ALARM TESTER.

and this offers great advantages, particularly in army and field work, where batteries are a positive objection.

The system of the National Magneto-Electric Telegraph Company is designed to operate fire alarms and telegraph lines, railroad semaphores, fog signals, etc. The electrical apparatus is of the simplest character and its operation seems to give satisfactory results.

The transmitter consists of a magneto whose armature is under constant spring tension. The tension is released by the operation of a transmitting key which is similar to the corresponding instrument of the Morse system. When the key is depressed the armature is released and makes one half of a revolution at a high rate under the influence of the spring. When the pressure of the fingers on the key is withdrawn the lever returns to its normal position, and the armature is again released and makes another half revolution. The armature therefore makes one complete revolution by depressing and releasing the key. In each half revolution the armature generates a current of one polarity and when it makes the next half turn the current is of the opposite polarity. Therefore the impulses sent to the line

are of alternating character, and being received on a polarized relay are translated into signals corresponding with those transmitted. The duration of the downward pressure on the key determines the dots and dashes, as on the Morse instruments.

The receiving relay used in the field signal system is enclosed in a light metal box, which may be strapped to the body. The relay armature is pivoted at the centre so that the ends move up and down, walking-beam fashion, over the poles of the electro-magnet, which are normally magnetized by means of a permanent magnet in the usual manner. The poles of the magnet are set a sufficient distance apart to permit of a diaphragm being placed between them, and under the armature, the plane of the diaphragm coinciding with that of the pole faces. Passing through the armature (which is flat) are two set screws, one on either side of the pivot. The lower ends of these screws impinge alternately upon the diaphragm as the armature vibrates between the poles, thus amplifying the sound which otherwise might be inaudible. The sound waves are conveyed to the ears of the operator by means of small rubber tubes with ear pieces attached for insertion in the ears. This arrangement makes an instrument very sensitive to sounds.

It is stated that the e. m. f. of the impulses sent out by the magneto is between 10,000 and 15,000 volts, the armature being wound with No. 32 wire. This high potential is largely obtained from the kick of the inductance of the armature due to the sudden stop after having made one half revolution. A curve representing the potential would show a sharp and high peak, with an almost vertical fall to zero. The method of obtaining this high potential is one of the strong basic principles of the system.

The magneto transmitter and the polarized relay form the basis of the various applications of the system. In fire alarm work the armature of the magneto is operated and controlled by clock-work, this latter feature being similar to that used in existing fire alarm systems. The receiving relay at headquarters controls the mechanism of a mechanical gong on which the alarm is sounded, at the same time a record of the signalling box number is made on a tape run through a recording instrument which is set in motion by secondary impulses. Provision is made to test the lines automatically at regular intervals of time. This feature of the apparatus is very ingenious. If any trouble exists on any of the circuits the fact is made known by the sounding of a gong, but so long as the lines are clear no alarm is given. In the apparatus on exhibition the test signal is applied every two and one-half minutes, but the time interval is not necessarily a fixed quantity for all installations—it may be made any length.

From the above description it is evident that the system may be applied to many uses where intermittent action is required at a distant point, such as the blowing of fog signals, sounding of bells, the operation of railway semaphores, exploding torpedoes, etc. One of the most important fields for the system will be found in railway electric signal work. Here, the battery is the weak point, and its elimination will be hailed as a distinct and positive gain.

The company has developed an auxiliary fire alarm system for use in connection with the ordinary telephone in private dwellings, factories, stores, etc., but since it does not directly involve the use of the system specifically considered, a detailed description of it need not be given here. It is an ingenious combination of the two services, however, and affords an important protection against fire, and is entirely automatic in its action. When in action, the exchange operator hears over the telephone the sound of the gong at the danger point, and takes the necessary steps to notify the fire department. Its action is independent of the presence of any one about the premises.

Fig. 1 is a diagrammatic view of the rear of the fire alarm testing instrument, a general front view of which is shown in Fig. 2, together with the recording instrument. Fig. 3 gives a diagrammatic sketch of the circuits of a fire alarm system.

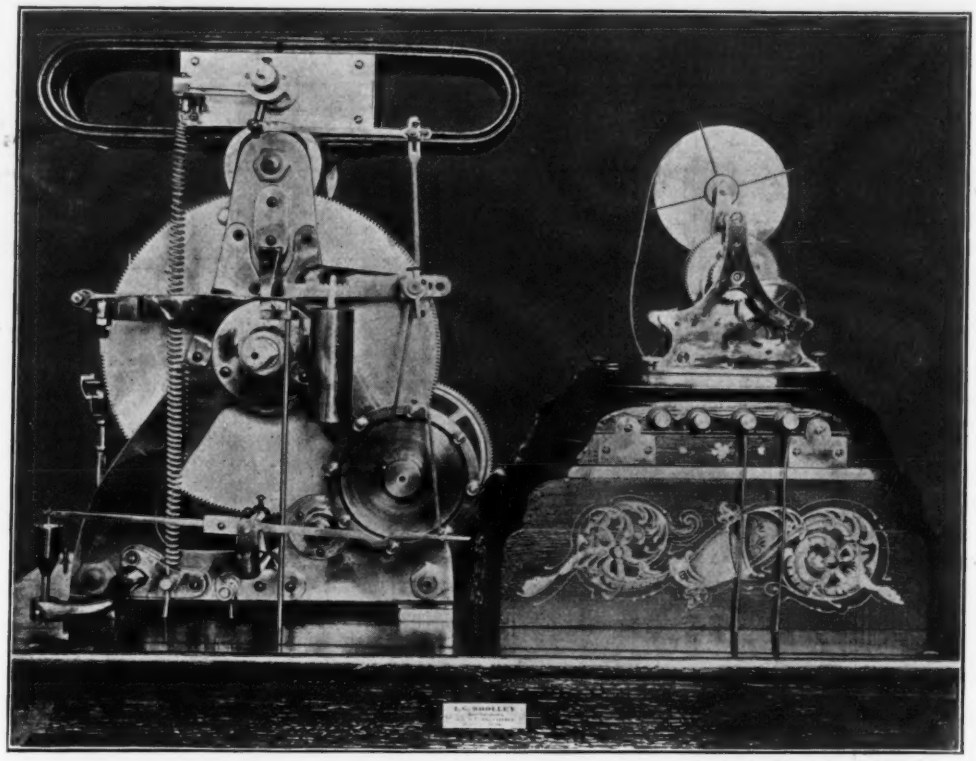


FIG. 2.—GENERAL VIEW OF FIRE ALARM TESTER AND RECORDER.

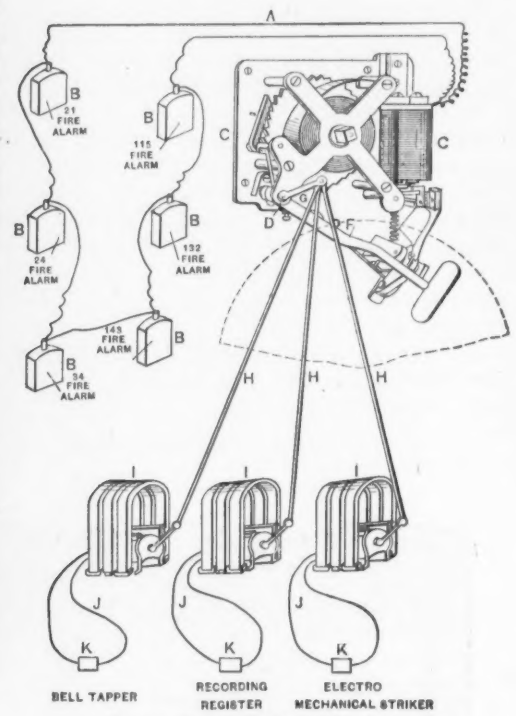
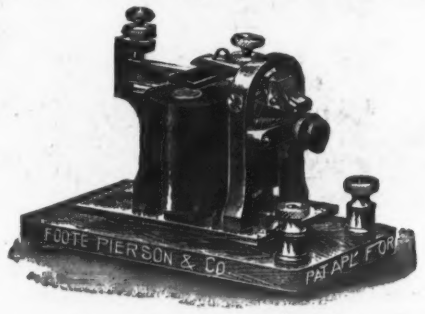


FIG. 3.—FIRE ALARM CIRCUITS.

The system of the National Magneto-Electric Telegraph Company is the invention of Mr. L. G. Woolley, who is secretary of the company.

Main Line Sounding Relay.

The accompanying illustration gives a view of a main line sounding relay, manufactured by Messrs. Foote, Pierson & Co., 82 Fulton Street, New York. The principal feature of the instrument is the original and simple method employed to adjust the armature to meet line conditions that may exist in any circuit. A simple turn of the screw on top of the lever moves the armature closer to or further from the magnets, giving a range of adjustment which will permit the instrument to operate on either a strong or a weak current. An-



MAIN LINE SOUNDING RELAY.

other practical feature is that when the adjustment of the armature is made, it in no way affects the adjustment of the other parts of the instrument, and as soon as an operator has found the proper adjustment the sounder is ready for work. When the adjustment is once obtained, the lock-nut on the screw makes it absolutely permanent, and no amount of severe use can change it. This instrument can be put in circuit where an ordinary relay is used and, it is stated, will work very satisfactorily.

The sounder is generally used in connection with a key mounted upon a mahogany base, which makes a very light, portable telegraph set that can be used on any main line. By the use of a delicate steel spring, the troublesome thread, which is frequently breaking, is abolished.

A Simple High Tension Sub-Station Equipment.

The accompanying illustrations refer to a high tension sub-station outfit made by S. Z. de Ferranti, Ltd., of London, and which has been installed in connection with a number of plants with successful results. The equipment is for use in transformer sub-stations or chambers for distributing the current from the in-coming feeders to the primary coils of the transformers, and includes switching appliances to cut off the supply to any transformer in case of repairs or removal, and also for automatically cutting out a transformer when through a fault an excess current flows. The device is made very simple in order to obviate expert supervision and is so constructed as to reduce to a minimum danger to attendants from contact with live parts of a circuit. To provide for the case of sub-stations or transformer chambers where the walls or the floors are damp, the insulation has received particular attention. Fig. 1 shows an arrangement for two feeders and eight transformers with and without a guard slate. Fig. 3 is a diagram of the connections for one feeder and three transformers, and Fig. 4 a similar diagram for two feeders and eight transformers.

One type of apparatus in practical use is shown in the accompanying illustrations. Fig. 3 shows the equipment in its simplest form. inner bus-bars, and so to either of the two incoming feeder cables. The outer bus-bar is also common to all cables. On systems where the outer bus-bar is not earthed at the central station, it is necessary

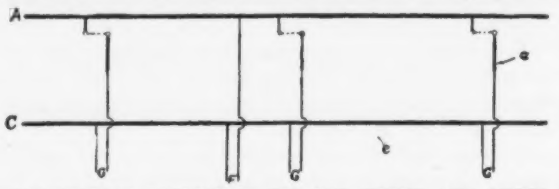


FIG. 3.—SUB-STATION EQUIPMENT FOR ONE FEEDER AND THREE TRANSFORMERS.

to have double-pole plug fuses so that the outers can be disconnected from the bars as well as the inners.

In the diagrams the incoming feeder cables *F* are connected by terminals (provided with means for sealing the ends of the cables) to the inner and outer bus-bars *A, B* and *C*, respectively. The cables *G G* leading to the transformers can be either single or concentric, the latter making the neater connection. The outers of these cables

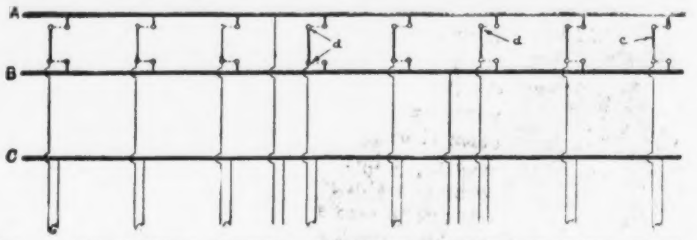
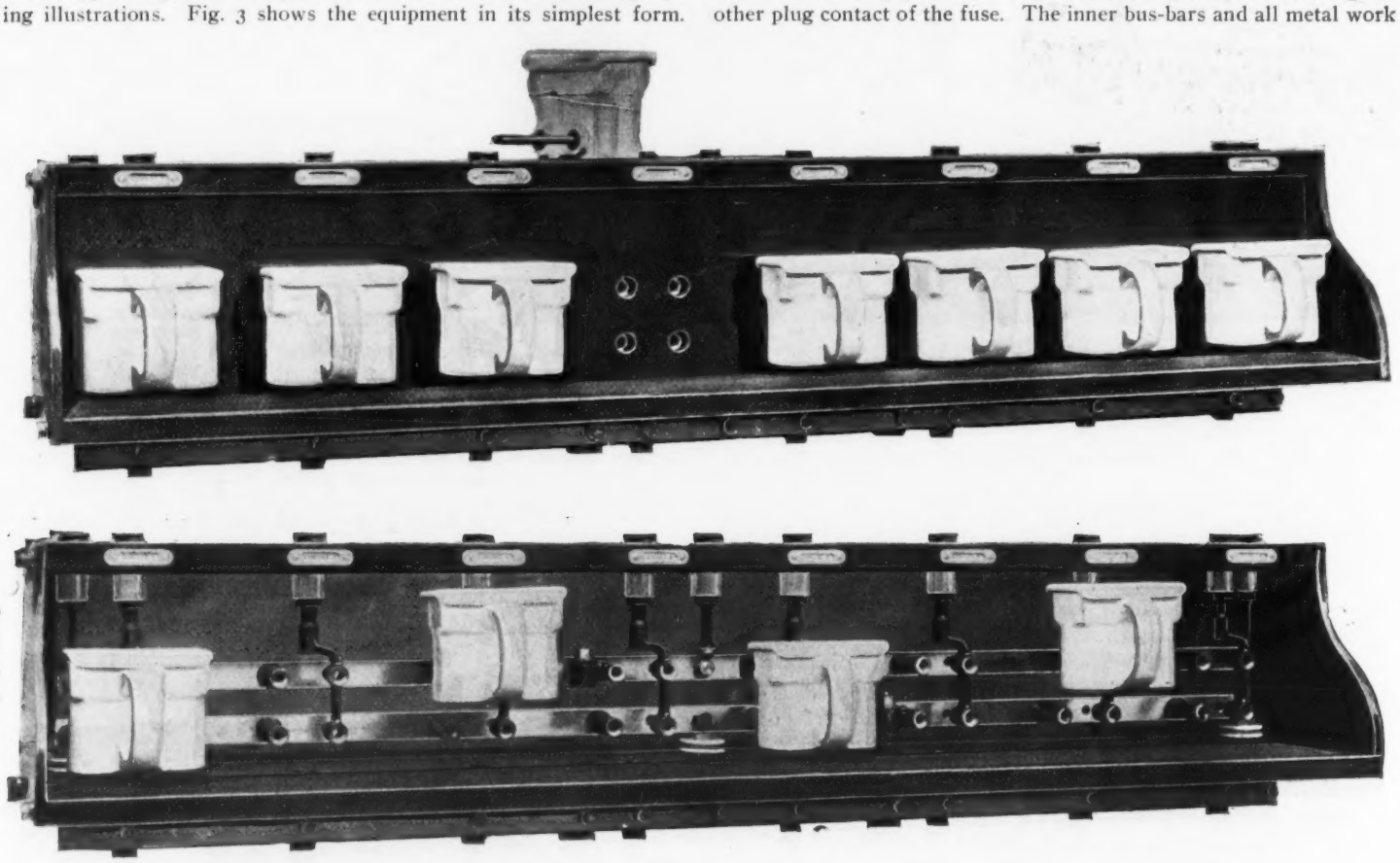


FIG. 4.—SUB-STATION EQUIPMENT FOR TWO FEEDERS AND EIGHT TRANSFORMERS.

connect direct to the common bar *C*, and the inner to a terminal casting carried from the top slate by porcelain insulators. This terminal casing is bored at *d* to receive one plug contact of the fuse, the bus-bars being provided with corresponding sockets receiving the other plug contact of the fuse. The inner bus-bars and all metal work



FIGS. 1 AND 2.—SUB-STATION EQUIPMENT FOR TWO FEEDERS AND EIG HT TRANSFORMERS.

The inner bar *A* receives the incoming feeder and feeds all the transformers in parallel through the well-known Ferranti oil-break plug fuse; the outer bar *C*, earthed at the central station, is common to all cables. Fig. 4 shows the same type of gear, but with two feeders connected to two inner bars respectively. In this case it is possible to plug any number of transformers in parallel on either of the two connected thereto are entirely covered in with slate framework, securely grouted into the sub-station wall. A guard slate covers the front, thus rendering it impossible to get a shock from the bars and connections.

In order to insure perfect insulation, all metal fittings carrying high tension current are first mounted in porcelain insulators and

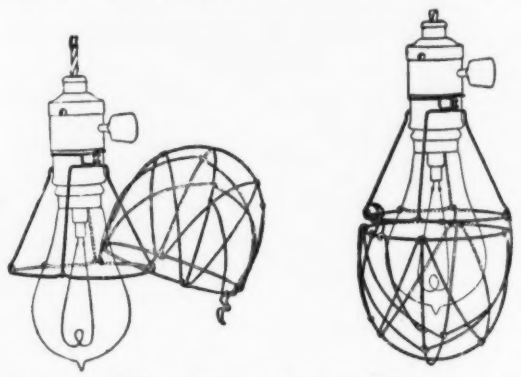
fixed into the slate framework by a special insulating compound. Thanks to the special construction of the slate work, any moisture running down from the walls will be stopped by the slate before it has an opportunity to get anywhere near the high tension fittings. The plug fuse is made up in a porcelain pot containing oil, which, at the moment of a fuse blowing, puts out the arc, and so automatically and surely disconnects the transformer from the source of supply. The fuse shown is suitable for a working capacity of 100 kilowatts at 2500 volts, or 75 kilowatts at any voltage up to 6000 volts, and only occupies a wall space in width of 9 ins. An ivory name plate is dropped into a metal frame mounted on the top slate over each panel.

Power Development at Sault Ste. Marie.

At Sault Ste. Marie, Ont., a great centre of electro-chemical industry is springing up. A company has been organized, with a capital of $30,000,000, to develop the water power on both the Canadian and United States sides. On the Canadian side, 14,000 horse-power are now being used, while 10,000 horse-power will be taken by the American Alkali Works. Other industries, such as nickel reduction works and chemical works, are contemplated.

Lamp Guards.

The accompanying illustrations show the "Improved Perfection" lamp guard, open and closed, which received the bronze medal, first



FIGS. 1 AND 2.—LAMP GUARDS.

prize, at the Paris Exposition. The objectionable feature of wire lamp guards, that of having to detach the guard from the socket in order to handle the lamp, is eliminated in this device. These guards are made to open and close in the middle, so that the lamps can be cleaned and handled with the greatest ease. For convenience, simplicity, firmness and neatness, these guards are commended by the manufacturers, the Wm. Inglis Wire Works, Detroit, Mich.

The Belden-Larwill Arc Lamps.

Any one investigating the arc lamps now being turned out by the Belden-Larwill Electric & Manufacturing Company, of Fort Wayne, Ind., can not fail to be impressed with the extreme simplicity of the lamp, as well as other points worthy of consideration. The external appearance of this line of arc lamps is shown in Fig. 1, while Fig. 2 shows the lamp with outer globe off ready for trimming, and Fig. 3 shows the doors of the casing which surrounds the mechanism open, exposing the mechanism of the constant potential lamp. The feeding mechanism consists of a single pair of conical pole magnets. The inner globe surrounds the whole carbon-holding mechanism, and the feeding is accomplished by letting the upper carbon slide down inside an enclosing cylinder, which cylinder with its clutch rests on top of the cap of the inner globe. The feed clutch acts directly on the upper carbon. The lamp gives good results with American carbons, and the rated life of carbons is 225 hours with a ½ in. x 12 in. upper carbon. As will be seen in Fig. 3, the resistance in series with the arc is placed in the lower part of the case while the magnet and its pivoted armature are placed in the top of the case.

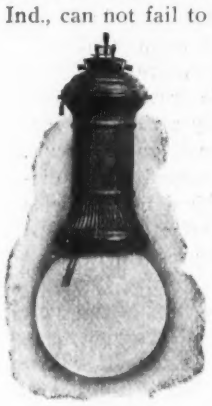


FIG. 1.

Among other advantages which may be noted as to this lamp are that there is no place about the lamp where it is necessary to have accurate alignment in assembling. The insulation is all lava and mica. The iron parts are copper-plated and blued over to make rust difficult.

FIG. 2.

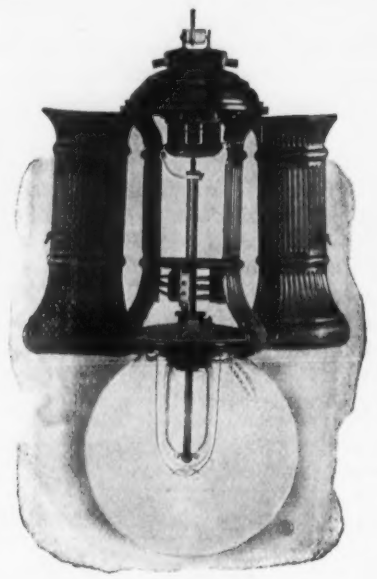


FIG. 3.

Trimming is easy. Having removed the globes, both carbons come out through the lower carbon holder. The top carbon is held in its socket by a spring clip. These lamps are made suitable for all kinds of commercial circuits.

A "Turn Down" Incandescent Lamp.

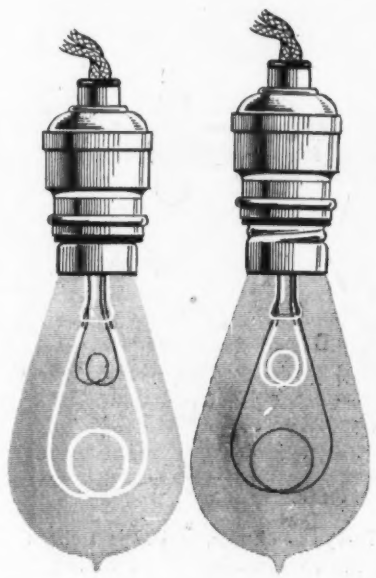


FIG. 1. FIG. 2.

The possibility of "turning down" or diminishing the illumination from an incandescent electric lamp has long been an attractive problem to engineers and inventors. Devices of various kinds have been produced to vary the light of a lamp from zero to maximum through intermediate steps or stages, and this graduation seems to have been regarded by the inventors as an essential feature The manufacturer of the "Hylo" lamp, illustrated herewith, takes a different view of the matter, however, and argues that generally two degrees of light are all that are needed —either turned down low, or turned up to the maximum. The "Hylo" lamp is designed on this principle, and contains two filaments, one of 1 candle-power and the other of 16 candle-power. By slightly unscrewing the lamp socket, the 16-cp filament is cut out of circuit and the "baby," or 1-cp filament, is cut in, the operation of "turning down" the light being quite as easy of performance as turning down a gas jet. The "baby" filament is designed to burn at a lower temperature than that of its near neighbor, the 16-cp filament, and on the average will outlive the latter. The life of the lamp is therefore the life of a good 50 or 60-watt filament plus the entire time that it has been turned down. Observations so far show that the total lamp life has ranged from 1200 to 7000 hours.

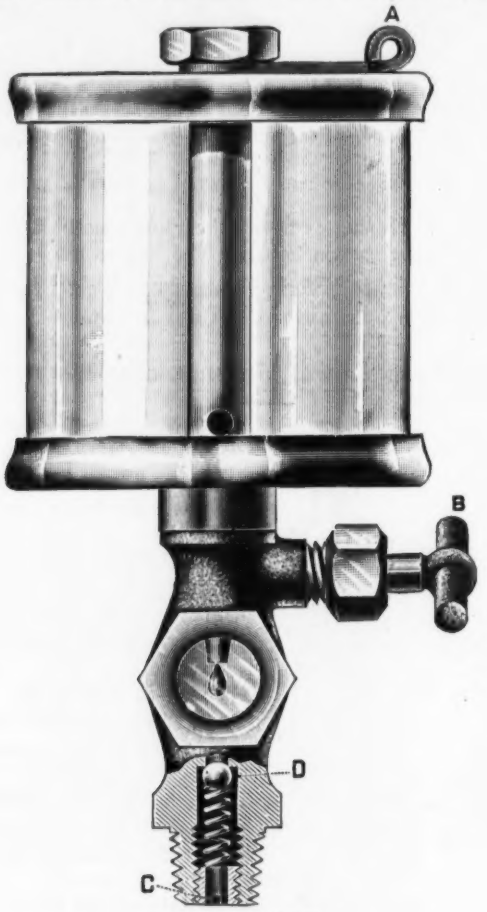
The Phelps Company, Elmwood, Ind., is the manufacturer of this lamp. In calling attention to the advantages of the lamp it points out that at a meter rate of 1 cent per lamp-hour, five-sixths of a cent is saved every hour that the lamp is turned down to 1 candle-power. In a common instance in which the lamp is turned up two hours of the night and turned down the balance of the night, the "baby" filament will last 3800 hours, and the saving, as compared with a common

lamp will be $25. One incidental advantage of the "baby" filament is that it is most likely to be turned down when the load is light and pressure high. In the case of this lamp the e. m. f. may swing through as much as 30 volts without doing any harm. By its use there is a tendency, therefore, to preserve the larger filament and prevent blackening of the bulb.

Fig. 1 shows the 16-cp filament aglow and the "baby" disconnected, and Fig. 2, the "baby" aglow and the larger filament cut out.

Sargent Gas Engine Oiler

The proper lubrication of the cylinder and piston of a gas or oil engine in which the average temperature during inflammation is not far from 2000 degs. F. is one of the essential conditions of successful operation. Fig. 1 illustrates an oiler designed especially for lubricating, not only the cylinders of gas or oil engines, but vacuum pumps and air compressors in which the pressure during the induction stroke is slightly below atmospheric pressure. The essential features are a glass reservoir, which is filled through a hole in the top normally covered by the slide *A*; *B* is a needle valve which adjusts the feed into the air-tight bull's-eye as shown, and *D* is a check valve held to its seat by a spring, the compression of which is adjusted by the nut *C*. While this is essentially a cylinder oiler, by removing all compression from the spring, it may be used in place of the ordinary sight-feed oiler on any other part of the engine.



GAS ENGINE OILER.

When this oiler is used for admitting oil to the cylinder of a gas engine or air compressor, the check valve spring is so adjusted that the valve seats when the air pressure above and below the check is the same; but if the air pressure below the check valve is rarefied or slightly reduced, the check will open and allow the air in the bull's-eye enclosure to pass into the cylinder, whereupon the atmospheric pressure on the oil in the reservoir will force the oil down through the needle valve to the bull's-eye chamber, from which it will pass into the cylinder every time the check valve opens. When the engine stops rarefaction in the cylinder ceases, the check valve remains seated and the oil stops feeding through the needle valve, because oil cannot drop into the bull's-eye chamber if air and oil are not drawn out. When compression begins in the cylinder, the check valve shuts and no smoke or pressure from the explosion passes into the bull's-eye chamber or reservoir.

The reservoir can be filled while the engine is stopped or running without opening or closing a valve or changing the adjustment of feed. This oiler is the invention of Mr. C. E. Sargent, and is manufactured in several sizes by the Michigan Lubricator Company, 255 Beaubein Street, Detroit, Mich.

Slow Speed Motors and Generators.

The New England Motor Company, Lowell, Mass., has lately placed upon the market a new type of slow speed direct connected motor and generator, designated as its Type F. These machines are equipped with an equalizing magnetic system, designed to meet the requirements peculiar to slow speed direct connected service.

Fig. 1 gives a good idea of the general appearance of the machine as arranged for direct connected work. A light but strong three-armed bracket carries the bearings at both commutator or coupling and rear end. In many cases only the front bracket and bearing are required, the other end being supported by the shaft to which the motor is connected. In the construction of the armature, machine wound, interchangeable coils, heavily insulated and then shaped, are used. The back end of the armature is protected from injury, oil and dust by a closely fitting metal shield. The winding is well below the surface of the core and is further protected by hardwood strips held in place by steel wire bands. The commutator is large in diameter, with ample brush surface and has sufficient number of segments to give commutation with a very small temperature rise.

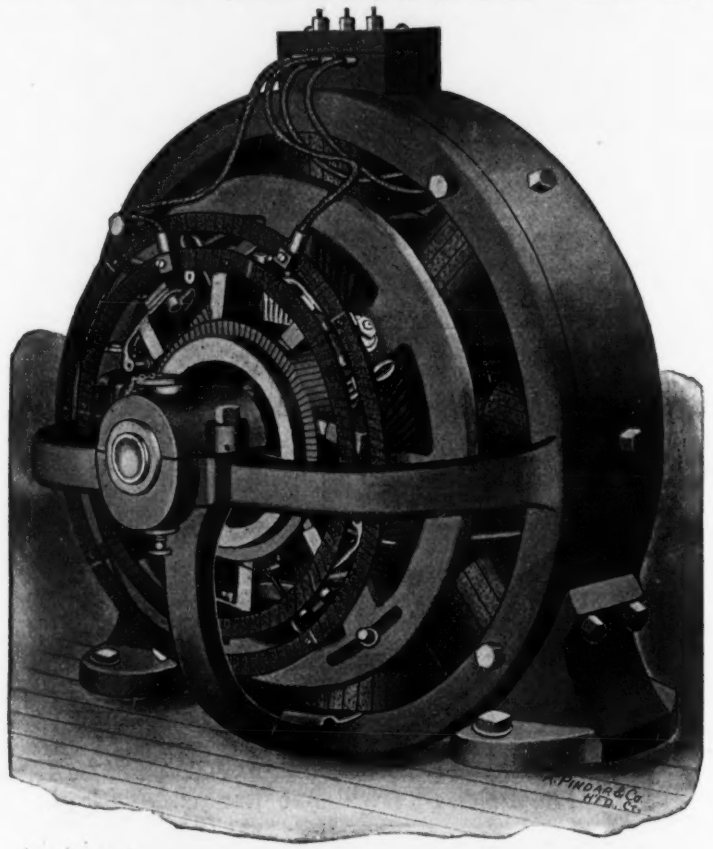


FIG. 1.—GENERAL VIEW, PARALLEL CONNECTED ARMATURE.

Fig. 2 gives a general idea of the equalizing pole system. All the shoes of like polarity are connected magnetically by a ring, the section of which bears a definite ratio to the rest of the magnetic circuit, so that any inequality in the strength of the field caused by the displacement of the armature, or accident to individual field coils is corrected; in other words, securing a practically perfect symmetrical field at all times. This is a specially valuable feature in generators and motors with a multiple circuit armature, and is claimed to be a decided improvement in two-circuit windings. The use of this pole system, together with the general careful design of the apparatus, admits of a relatively high speed being attained when desirable. The company is making motors and dynamos of this type, with a high efficiency and low temperature limit, running at a speed considerably greater than is found in similar machines in general use. The brush ring is mounted on one of the pole rings. Another important advantage claimed for this method of mounting the pole shoes is that, owing to the fact that they are adjusted in a rotary direction, the saturation at the pole tips can be varied; in other words, the density of

the commutating fringe can be changed, and this while the machine is running under load and without it being necessary to vary the field excitation or any other electrical detail of the machine. This is

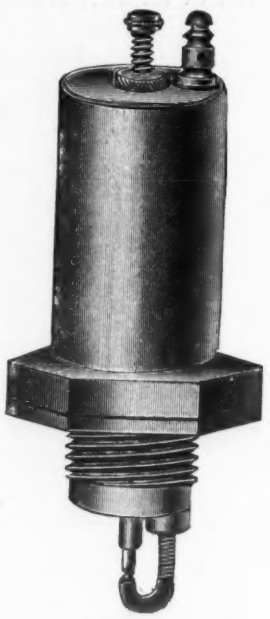
FIG. 2.—POLE SYSTEM, WITH EQUALIZING RINGS.

effected by simply shifting the position of the pole faces relative to the field cores which excite them.

These motors and generators are manufactured in sizes from ½ horse-power to 30 horse-power, and to run at speeds ranging from 100 r. p. m. up. Motors when so ordered may be arranged to hang inverted from the ceiling, on the wall or with the shaft in a vertical plane.

New Ignition Plug for Gas Engines.

The accompanying illustration shows a new form of touch-spark ignition plug for internal combustion engines which contains many novel features. The plug is completely self-contained, there being no necessity for employing the customary auxiliary spark coil. The spark is produced between two platinum points, one of which forms the end of a brass plunger which passes through the centre of the apparatus, and the other the end of a curved arm, as shown in the figure. The two platinum points are held normally in contact by a spring which presses against the extremity of the plunger and the tension of which can be regulated by the thumb screw on the end of the casing. The plunger carries an iron armature and is surrounded by the coil of an electromagnet which, when excited, attracts the armature and separates the spark terminals. The current which operates the breaking action is the same as produces the spark, the self-induction of the magnet acting like a spark coil and giving a very effective spark. The plug is screwed into the engine in the ordinary way, but the portion which projects outside is carefully insulated from the same by a durable lava washer. In an improved form which is now being put upon the market, this washer is entirely enclosed by the casing of the plug. The binding post at the end of the device is electrically connected through the magnet coil to the plunger. One terminal of the battery is connected to this, the other being attached to the frame, and so leading the current to the other sparking point on the bent arm. The appliance gives excellent results whether used on a storage battery, four volts being sufficient to operate it satisfactorily, or in connection with a sparking dynamo. Especial attention has been paid to making the insulation as perfect as possible, the high temperatures to which this class of apparatus is subjected making this an important item. All the magnet wire is wound with asbestos, and the lava washer is practically indestructible.



IGNITION PLUG.

A storage battery which has given excellent results in practice is manufactured in conjunction with the ignition plug. The battery is of the Planté type. The cells are made of lead, the walls of the cell itself being one plate; the other plate is suspended in the electrolyte. By the ingenious method of having the cell made with two compartments and two suspended plates, four volts can be obtained from what appears to be a single cell. The walls of the cell are positive to one element and negative to the other, so that a duplex battery is produced without any soldered or rivetted connections.

The devices described above are the inventions of V. G. Apple, secretary of the Dayton Electric Manufacturing Company, Dayton, Ohio, and are being manufactured by that company.

A New England Telephone Factory.

The development of the "independent" telephone movement is popularly supposed to have occurred chiefly in the West, both as to the organization of local companies and the production of apparatus. It is the fact, however, that the East is the headquarters of that movement and that a large part of the industry is centered there, some of the best apparatus being actually made in what might be called the heart of the "enemy's country." One of the largest and newest factories is that of the Couch & Seeley Company, of Boston, in which its well known instruments and switchboards are manufactured.

It scarcely seems credible that within the year and a half since this company was organized, at that time taking over the business formerly conducted by Messrs. Whitman & Couch in the same line, it could have developed to the extent that an examination of its working facilities indicates. Its present quarters at 24 to 28 Binford Street are in one of the largest manufacturing buildings in Boston. It occupies already four floors with an aggregate floor space of 32,000 ft. The first floor is required wholly for the offices, stock room and shipping department. On this floor is carried a large stock of all line materials and miscellaneous supplies required in the telephone line, and in such quantities as to enable prompt shipments for anything in the telephone line.

On the second floor is located the machine department. Here all parts and all work of every description in the making of various details of complete equipment are produced. One section of this floor is occupied by the tool making department; another section by the nickel plating and buffing room, a third section by screw machines, and a fourth section by lathes, drills, power presses, etc.; this entire floor being devoted exclusively to the making of parts of the apparatus, and this applies equally to switchboards and telephone instruments.

On the third and fourth floors are the assembling departments. One of these sections, under the supervision of a competent foreman, assembles all transmitters in the various forms adapted for exchange and other uses, both the standard type for attaching directly to bell boxes or similar mountings, as well as the rocker arm for the standard exchange instrument; also receivers, desk sets, swing arm sets, hand micro-telephones, etc.

In another section there are assembled complete exchange instruments, and nothing is handled in it whatever except the standard type of wall exchange instrument. In still another department is assembled its line of interior apparatus. It is thought that this is probably the largest department devoted to interior telephone equipment in existence. The systems are adapted to hotel and school use, with inter-communicating equipment, covering the common return, complete metallic circuit and automatic button systems. This department has been largely developed by the demand from independent exchange managers for a grade of equipment suitable for installation in private plants, and at the same time such that connection can be made for long-distance work.

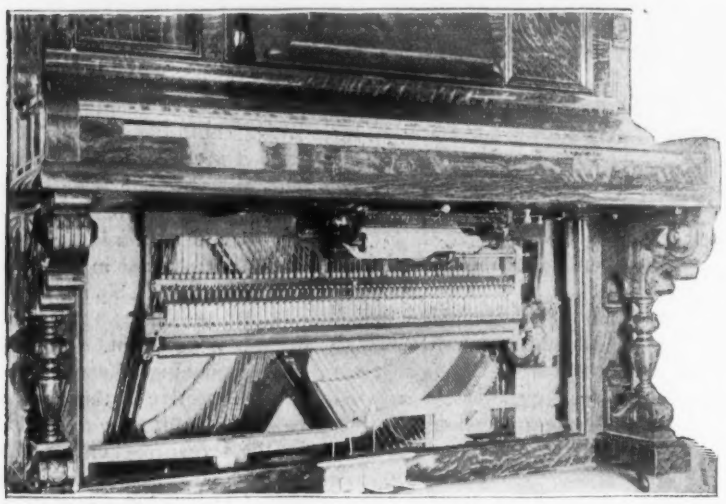
Another department is occupied entirely in the assembling and building of switchboards, and adjacent to the present switchboard department is another section occupied in the development of central energy equipment, which it proposes placing on the market in the very near future. In addition to these departments are many of minor importance, yet all contributing to the same result, namely, the production of what it aims at making, the highest grade of telephone equipment.

The manufacturing part of the business is directly under the super-

vision of Mr. Couch, who is ably assisted by Mr. C. F. H. Franke, who is well known in connection with his past experience in the independent telephone field.

The Improved Pianophone.

The accompanying engraving illustrates a new style of self-playing piano which has all the advantages of the self-contained electric piano, and at the same time enables the operator to have complete control of the quality of the music. This instrument represents some important improvements over that described in our issue of Dec. 23, 1899. The action is produced by a most ingenious device which requires but a small amount of energy to operate it, so that a large saving results in the size of battery necessary. A 1-in. steel rod or shaft runs horizontally immediately below the ends of the piano keys. This shaft is revolved at a moderate rate of speed by a small motor on the right which is under the direct control of the player. A small boot-shaped block of wood is supported about 1-32d of an inch above the shaft under each key and is connected to the key lever by a small rod. When these blocks of wood are depressed by the action of a magnet, their lower surface, which is covered with monkey skin, rests against the revolving steel rod, which throws them to the rear and raises the connecting rod and key lever. The end of the key lever on the opposite side of the fulcrum from the key is raised so that a blow is struck on the wires by the hammers of the piano action. The result is the same as if a downward blow had been struck upon the key by the finger, the similarity of operation being further increased by having the upper ends of the connecting rods covered with felt.



VIEW OF SELF-PLAYING PIANO.

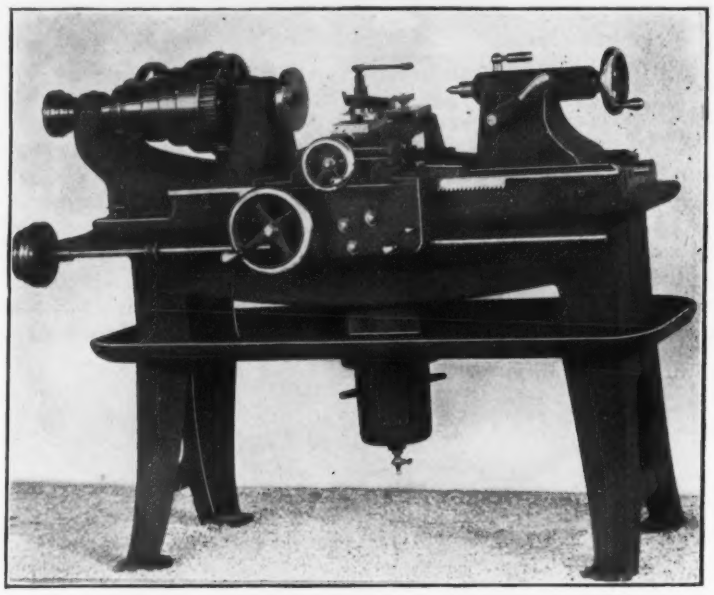
The magnets controlling the key action are operated by circuits which are completed through a perforated strip of paper. The reels upon which this paper is wound are run by the same motor as the steel shaft, but a friction bearing and belt keep its speed constant irrespective of the speed of the motor. The speed of the motor determines the strength of the blow struck by the hammer and the speed of the perforated paper determines the tempo; as both of these speeds are under the control of the player, the music produced is entirely dependent upon his wishes.

The compactness of the apparatus and the small space occupied by the storage battery when one is used, recommend this device for use in private houses. The Pianophone is one of the latest inventions of Mr. G. Howlett Davis, and is being manufactured by the Pianophone Company, of New York, at its Brooklyn factory.

Positive Turning Taper Lathe.

The machine here illustrated is an improved positive taper turning lathe designed by Mr. John J. Grant, and made by the Grant Tool Company, Cleveland, Ohio, which is a particularly handy tool for turning studs, bolts, etc. It swings 12½ ins. over ways and 7½ ins. over the carriage, the greatest distance between the centres being 20 ins. back gear and 5-1. The cone is four steps over a 2-in. bolt, the largest step being 9 ins. in diameter. The line spindle is made of hammered steel. The front box is 2¼ ins. in diameter by 5 ins. long, and the foot stock is clamped by an eccentric lever.

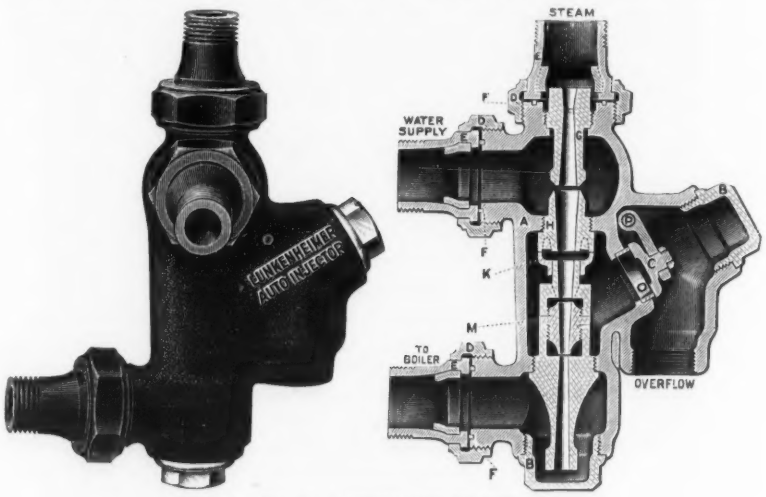
The construction of the lathe is interesting. The head and foot stock are bolted to a swiveled plate which is securely fitted to the bed and held in position by gib bolts, and can be adjusted to any taper up to one inch per foot, the centre of the head and foot block always remaining in line so that work of different lengths will be turned by exactly the same taper without reseating. The carriage has an automatic stop motion with a drop feed, which obviates the necessity of slacking any friction device before running the carriage back. The lathe is made either with or without the pan shown in the cut. The tool is applicable for all classes of turning and should prove a particularly valuable one for the manufacturers of electrical apparatus.



TAPER TURNING LATHE.

Lunkenheimer Automatic Injector.

The two accompanying illustrations show a general view and cross section of a Lunkenheimer automatic injector designed for the feeding of boilers of stationary, portable or traction engines, steamboats, etc. The body is of cast-iron and the tubes of special hard bronze composition, all of the wearing parts being renewable at slight expense. The apparatus is claimed to be very efficient, both mechanically and on the basis of the delivery of water per pound of steam. As shown in the sectional view, it is of simple construction. The tubes are all screwed in place and the apparatus is carefully tested before shipment. It operates under a wide range of steam pressure, with the feed water at 75 degs. Its capacity can be graded over 50 per cent with steam pressures from 60 to 100 pounds, and feed water at 75 degs. These injectors are made in 12 sizes, and are suitable for throttling engines ranging from 10 to 375 horse-power. They are manufactured by the Lunkenheimer Company, Cincinnati, Ohio.



FIGS. 1 AND 2.—AUTOMATIC INJECTOR.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Marked advances with great activity were scored in some stocks last week, but the market as a whole yielded somewhat to bear influences. The industrials were irregular, the leading iron and steel specialties developing weakness on reports of overproduction and a tendency to reduce prices. The principal electric stocks showed firmness, all, with the exception of Western Union, closing with substantial net advances over the previous week. Brooklyn Rapid Transit is 3¼ points higher, the sales being 373,407 shares. The range of prices was between 70⅝ and 78¾. General Electric closed with a net gain of 2¾ points, 17,658 shares having been sold. Metropolitan Street Railway made a net gain of 2½ points, the range being between 170 and 177. Western Union lost 1⅞ points. In outside securities the market showed some improvement over the preceding week. A number of net gains, amounting to several points, showed in some lines, and the advances far outnumbered the declines. The largest trading of the week occurred in copper stocks, most of which were active and strong. The electrics did not fare so well as those of other groups, and, on the whole, the market for these shows more declines than advances Following are the closing quotations:

NEW YORK.

	Nov. 17.	Nov. 24.		Nov. 17.	Nov. 24.
Gen. Electric	165½	168¼	Elec. Veh.	20	20
Bklyn Rap. Tran.	70¾	74	Elec. Veh., pfd.	45	40
Met. St. Ry.	170¾	173	Gen. Car	5	4¾
Am. Tel. & C.	91	—	Ill. Elec. Veh. Tran.	1¼	1¼
West. Un. Tel.	86	84⅛	N. Y. Elec. Veh. Tran.	7	6⅝
Am. Dist. Tel.	34	36	N. E. Elec. Veh. Tran.	3¾	3¾
Com. Cable	170	—	Tel. & Tel. Co. of Am.	5	5
Elec. Boat	17	18	Hud. Riv. Tel.	116	116
Elec. Boat, pfd.	41	35	N. Y. & N. J. Tel.	150	150

BOSTON.

	Nov. 17.	Nov. 24.		Nov. 17.	Nov. 24.
New Eng. Tel.	—	—	Erie Tel.	105	109
Mex. Tel.	3	2¾	Gen. Elec., pfd.	141	141
Westing. Elec.	*52½	52	Am. Tel. & Tel.	155½	159
Westing, Elec., pfd.	—	64	Ed. Elec. Lt.	—	—

PHILADELPHIA.

	Nov. 17.	Nov. 24.		Nov. 17.	Nov. 24.
Elec. Stor. Bat.	83	88	Phil. Elec.	3⅛	4⅝
Elec. Stor. Bat., pfd.	83	89	Pa. Elec. Veh.	4	4
Elec. Co. of Am.	10¾	10⅛	Pa. Elec. Veh., pfd.	*2	1½
Gen. Elec. Auto	¼	¼	Am. Rys.	38½	35¾

CHICAGO.

	Nov. 17.	Nov. 24.		Nov. 17.	Nov. 24.
Chicago Edison	142	142	Chicago Telep. Co.	215	220
Chic. City Ry.	255	255	Union Traction	14¼	13¼
Nat'l Carbon	17	16½	Union Traction, pfd.	54½	54½
Nat'l Carbon, pfd.	82	82	Northwest Elev. Com.	29½	27

*Asked.

DIVIDEND.—The American District Telegraph Company, of Brooklyn, N. Y., has declared a dividend of 3 per cent, payable Dec. 10.

BROOKLYN, N. Y.—The Kings County Electric Light & Power Company has given the necessary 30 days' notice of its intention to issue $520,000 (in par value) additional capital stock.

THE BROOKLYN RAPID TRANSIT RAILROAD reports gross earnings for October of $991,454, an increase of $9,834 as compared with the same month of last year, and net $351,472, an increase of $65,306.

THE TWIN CITY RAPID TRANSIT RAILROAD reports gross earnings for October of $240,793, an increase of $11,584 as compared with the same month of last year, and net $131,291, an increase of $7,695.

AMERICAN TELEGRAPH & TELEPHONE.—On Jan. 15, 1901, the American Telegraph & Telephone Company will issue 80,000 shares of new stock to its shareholders at par ($100) per share, namely, $8,000,000, thereby completing the issue authorized in the early part of this year.

SOUTHERN TELEPHONE CONSOLIDATION.—It is stated that the Southern Bell Telephone & Telegraph Company and the Cumberland Telephone Company, operating in the Southern States, are to be consolidated under a single management in the immediate future. President James E. Caldwell and General Manager Leland Hume, of the Cumberland Telephone & Telegraph Company, which is the Bell organization in Tennessee, have been inspecting the property.

GENERAL ELECTRIC.—Of the $5,298,000 General Electric 5 per cent debenture bonds outstanding at the time the stockholders authorized an increase of stock by $4,415,000, with which to retire these bonds, it is estimated that $3,000,000 will be exchanged for stock, on the basis of one share of common stock for each $120 represented by the principal of the bond at the time of such redemption. About $2,000,000 of the bonds, it is expected, will not be exchanged, as this amount is held by trustees who paid less than par for them, and they are content to allow the investment to remain undisturbed. It is said that the exchange has thus far been small, although the recent rapid advance in the stock may help bring out the bonds.

THE AMERICAN BRIDGE COMPANY has just closed a contract with the North German Lloyd Steamship Company, calling for the erection of two steel buildings on the banks of the River Weser, at Bremen, Germany. The machine shop building will be 100 ft. in width and 300 ft. in length, two stories in height. The foundry building is 75 ft. in width and about 600 ft. in length. Both buildings are designed after the best American practice. The contract has been secured by the American Bridge Company in competition with the best German bridge shops, and shows the extent to which this class of work can be carried. This is a great triumph for the American Bridge Company, and we hope it will lead to further contracts of the same kind.

MANHATTAN.—The advance in Manhattan grows out of the annual report. A study of this report shows that Manhattan could earn 4 per cent on the stock under existing conditions, and that the turn in the company's affairs as far as increase in business was concerned had come. From this standpoint it was possible to figure the saving from electric equipment, which would add at the lowest calculation more than 1 per cent to earnings with the present volume of business. It could be assumed also that electric equipment, station elevators, etc., would bring additional traffic, which would be so much more added to earnings, enabling the management to look upon Manhattan as likely during the coming year to show some approach to 6 per cent. It is said that there are indications that negotiations for the lease of the Manhattan to the Metropolitan are still going on. The terms mentioned are that the Metropolitan offered to lease Manhattan, guaranteeing 5 per cent annually on its stock for a certain period of years and a larger amount thereafter.

ERIE TELEPHONE OFFICES.—The Erie Telegraph & Telephone Company will abandon their Lowell offices about Dec. 1 and will locate their entire clerical force in New York and Boston. In New York the company will occupy the eighteenth floor in the American Surety Company Building at 100 Broadway, and in Boston the fourth floor in the building at 15 Congress Street. The departments transferred to New York will be those of President Glidden, Vice-President Pettengill, Secretary Perham, General Auditor Thorpe and Advertising Manager Greenslitt; to Boston, Vice-President Adams and Treasurer Grant. A private telegraph line will connect the New York and Boston offices. President Glidden says that he will divide his time between the New York and Boston offices, and expects to visit Lowell frequently. This removal is regarded in many quarters as evidence of the growing importance and magnitude of the Erie interests.

NORTH AMERICAN.—At the meeting of the directors of the Milwaukee Electric on Dec. 1 a report will be submitted recommending the expenditure of $1,000,000 a year for five years upon the city properties and amounts upon the suburban properties depending on the extensions. The city improvements recommended are the enlargement in the central power house, additions to machinery and lighting houses, and the construction of a new central car station and office building in the city. The report will recommend the extension of the underground conduit system for lighting and the construction of new lines under the franchise acquired last January; also additional equipment to meet the increased business. In the report on suburban improvements the extension of line in the new territory will be recommended, also some reconstruction to permit high speed to Milwaukee and neighboring cities and the extension of the lighting service to other towns.

Commercial Intelligence.

THE WEEK IN TRADE.—During the past week the weather conditions have been unsettled, with a consequent depressing effect on the distribution of commodities and merchandise. There is, however, little or no loss of strength at the foundation; indeed, the general level of prices for staples is a trifle higher than those of the previous week,

notwithstanding the temporary adverse influences. In the iron market the conditions reported the previous week are not materially changed. Other metals, notably copper, are strong. Quotations for this metal on 'Change are 16¾@17c. for Lake Superior ingot, and 16⅝c. for electrolytic and casting. Sixty-two railways report the gross earnings during the second week of November as $10,595,778, a slight increase as compared with the same week last year. *Bradstreet's* reports the number of failures during the week as 215, against 227 the week previous, 202 the same week last year, 182 in 1898, 233 in 1897, and 296 in 1896.

THE MILWAUKEE ELECTRIC COMPANY, Milwaukee, Wis., has increased its capital stock to $200,000 and expects to increase its facilities to a large extent.

THE CENTURY TELEPHONE CONSTRUCTION COMPANY, of Cleveland, Ohio., has begun the construction of a 400-number exchange and lines at Salamanca, N. Y.

THE AMERICAN BRIDGE COMPANY is furnishing, from its East Berlin, (Conn.) plant, the steel work for power station No. 3 for the Hartford Electric Light Company, at Hartford, Conn.

A. B. SWARTZ & COMPANY, of Hagerstown, Md., have been awarded the entire contract for the construction and installation of all the machinery to be used in lighting the town of Boonsboro, Md.

FAN MOTORS FOR AUSTRALIA.—The Geo. C. Towle Manufacturing Company, Lancaster, Pa., reports that it has just received a third order for fan motors from Australia. The company also states that it will, in a few weeks, put upon the market an entirely new desk fan for the season of 1901.

SENATOR W. N. CLARK, of Montana, is to build on upper Fifth Avenue one of the costliest houses in New York City. The electrical work, which is of a very extensive character, is in the hands of Mr. Fremont Wilson. Mr. W. J. Baldwin is consulting engineer on the heating, ventilating, etc.

THE RAILWAY EQUIPMENT COMPANY, Cincinnati, is getting out a new catalogue to be issued for the first of the year. Manager McCallum reports a vast amount of inquiry for street railway work, much of it from abroad. The bulk of inquiries comes from South America, Mexico and Germany.

THE MICHIGAN ELECTRIC COMPANY, of Detroit, was awarded the contract for a 600-kw alternating current generator, a 200-hp electric motor, a 40-kw exciter and equipment for a switchboard by the public lighting commission. The Detroit firm is acting as agent for the Stanley Company, of Pittsfield, Mass., and assumes the responsibility for all the necessary increase in the plant, details of which will cost $39,000.

THE STANLEY ELECTRIC & MANUFACTURING COMPANY has received an order for a 500-kw generator to be installed in the water power plant of the Lehigh Power Company, of Scranton, Pa. The Stanley Company has also received an order for three 500-kw generators for the new plant of the Trenton (N. J.) Gas & Electric Company, direct connected to Pennsylvania Iron Works engines.

LAMP MANUFACTURE.—A new incandescent lamp manufacturing company has entered the field. The factory is situated at Hartford, Conn. The lamp will be known as the "Femco" lamp, the company being the Franklin Electric Manufacturing Company. The manufacturing part of the business is in charge of Mr. John Waring, the selling department being taken care of by Mr. Charles I. Hills in New York, and Mr. Jonathan Camp in Hartford. These are well-known names and justify confidence in the product of the new plant.

ORDER FOR NEW HOLLAND BOAT.—The United States Navy Department has entered into a contract with the Holland Submarine Boat Company for the construction of a boat of the type of the six heretofore contracted for, to replace the "Plunger," the company agreeing to take the "Plunger" off the hands of the Government and to build in her place the best type of modern submarine boat for the sum of $170,000, refunding to the Government the sum of $90,000 already paid on the "Plunger," and the sum of $4,365, which represents other expenses to which the Government has been subjected.

THE WESTERN TELEPHONE CONSTRUCTION COMPANY, Chicago, has secured the contract to furnish the Binghamton, N. Y., telephone exchange with a 2400-capacity, 1200 filled up, complete central energy equipment. The company has recently furnished the Chicago & Alton Railroad with telephone equipment for its main line between Chicago and Bloomington, connecting the general offices of the company in Chicago and the Union Station with Bloomington and other points along the line. It has also furnished the Union Elevated Loop, Chicago, with telephone equipment, connecting the main offices in the Fisher Building with all its stations upon the loop.

CONSOLIDATION IN CANADA.—The Royal Electric Company, of Montreal, is reported to be about to dispose of its manufacturing business to the Canadian General Electric Company for a consideration of $750,000. The acquisition by the Canadian General Electric Company of the large plant and good-will of the extensive patronage of the Royal Company's manufacturing business would practically give it a monopoly of the business in Canada. The Royal Company would then be left with a clear hand to pursue to a successful conclusion some of the ambitious schemes which are credited to the directorate. One of the first of these is said to be the acquisition of the Gas Company, of Montreal, and the Lachine Rapids Company, thus practically controlling the lighting business of Montreal. After that it is proposed to amalgamate all the electric railway lines on the island of Montreal under one system.

ELECTRICITY IN MEXICO.—Hon. Lucien J. Jerome, British Consul at the City of Mexico, has just completed for his Government an interesting report on the trade and industrial conditions of Mexico. He refers to the extensive use of electric light and of power in the industries and mining in Mexico. Electric batteries imported during the year 1899, he states, amounted to 100 tons, valued at $46,960 gold, of which 72 tons came from the United States, invoiced at $31,825 gold; 10 tons, at $8,880, from Germany; 2½ tons, at $660 gold, from France; 1½ tons, at $2,045, from England, and 3 tons, at $2,910, from Sweden. Electric incandescent lamps were imported to a total value of $9,495, of which more than one-half came from the United States, and the rest, with the exception of an insignificant quantity from England, were shipped from Germany. There will always be a demand for these and other electric lamps, he reports, as nearly every town in the republic is lighted by electricity.

LONDON TRACTION.—A cable dispatch from London of Nov. 24 says: Hot on the heels of Charles T. Yerkes' underground railroad scheme comes the announcements of so many projected roads that London may be said to have become the victim of the tube mania. If all the companies were allowed to operate, half of London would be undermined. Parliamentary sanction will be applied for in the case of no less than ten electric tubes, necessitating the deposit of £5,000,000 as Parliamentary guarantee. It is likely that several of these plans will never materialize, but, as D. H. Louderback, who is here in the interest of Mr. Yerkes, points out, there is no reason why London should suffer from lack of transportation facilities, when capital is going begging and the electrical science of the world is at its beck and call. Albert L. Johnson, of New York, is interested in an entirely different scheme, his interests lying in the direction of suburban surface traction, especially in Manchester and Liverpool and the large cities of the north, where he is acquiring important concessions. The underground roads in London under construction are the Baker Street and Waterloo, the Charing Cross, Euston and Hampstead and the Great Northern and Strand. The railways authorized are the Brompton and Piccadilly Circus, the City and Brixton and the Northwest London. The Parliamentary advertisements foreshadow the building of eleven more railways. These will radiate in all directions to the suburbs. Mr. Yerkes asks for power to extend the line to the north of Hampstead Heath, so as to run as a surface line away to Golder's Green, at Hendon, and to build extensions from Kentish Town to Highgate and from Charing Cross to Victoria.

NEW LUNKENHEIMER SHOPS.—The new machine shop building which the Lunkenheimer Company has just completed in Cincinnati, Ohio, is 90 ft. wide by 170 ft. long, two stories and basement, and is built on the usual machine shop gallery style of construction. There is a traveling crane 30 ft. wide which runs the full length of the building, leaving galleries on the second floor, on both sides, 30 ft. wide. The construction is steel throughout and designed to safely carry a load of 300 lbs. per sq. ft. This building was erected for the purpose of taking care of three important departments of the company, viz: Iron valve, injector and safety valve. It is, strictly speaking, a model machine shop and is equipped throughout with the very latest tools and appliances for producing the articles mentioned above. The steam plant consists of a 125-hp special Babcock & Wilcox boiler, built for a safe working pressure of 400 lbs. per sq. in. In connection with this boiler there are a number of appliances for testing all goods under steam, air and hydraulic pressure. The building is lighted by electricity and the power is furnished by a 100-hp engine. The exterior presents a very handsome appearance, it being pressed brick throughout. The location is an excellent one for manufacturing; railroad facilities are ample, and a track spur from the C., H. & D. Railroad leads to one side of the building. The erection of this building will not, in any way, reduce the building now occupied by the company on East Eighth Street, Cincinnati, which will hereafter be entirely devoted to brass work. The company contemplates the erection of a large building on some other property which it owns, which is adjacent to the new building, but it is not likely that this will be carried out for another year. By the erection of this new building the manufacturing facilities have been increased about 25 per cent, and employment is given to 100 men in addition to the force already operated, bringing the total force up to 500 hands, all of whom are engaged in the production of strictly high grade brass and iron goods and engineering appliances.

Special Correspondence.

ENGLISH NOTES.

LONDON OFFICE ELECTRICAL WORLD AND ENGINEER,
Nov. 17, 1900.

THE BRITISH SCHUCKERT ELECTRIC COMPANY, owing to the rapid development of its business in the north of England, has opened a branch office at Cleveland Buildings, 94 Market Street, Manchester, under the management of Mr. Frank Sinclair, who will in future represent it throughout the counties of Lancashire, Cheshire, Westmoreland and Cumberland.

CONTRACTS IN NATAL.—One of the most important contracts lately placed is that for the electric equipment of the tramways of Durban, Natal. Hubert, Davies & Spain, of Durban and Johannesburg, have secured the contract for laying the track at the price of £38,000, while Macartney & McElroy, of London, have secured the contract for the overhead equipment for £16,994 10s. 10d., and also the contract for the cars at £18,600. The contract for the power house and generating plant was secured by Dick, Kerr & Company, of London, for £26,240 10s. The lowest tender for the overhead equipment was that of Reunert & Lenz, Durban and Johannesburg, which amounted to £16,427 14s. 3d., and the highest that of Willing Bros., Limited, London, for £125,368. The lowest tender for the cars was that of Lowden Bros., Dundee, for £15,905, and the highest that of Willing Bros., Limited, London, for £26,300. For the generating plant the lowest tender was that of R. W. Blackwell & Company, Limited, London, at £20,417 10s., as compared with alternative tenders submitted by Hubert, Davies & Spain, Durban, of £24,010 and £30,723 10s.

THE ST. GEORGE, HANOVER SQUARE, VESTRY has entered into an agreement with the Westminster Electric Supply Corporation, Limited, to light the public thoroughfares of the parish with electricity. The installation is to consist, in the first place, of 600 arc lamps for continuous current of 500 or 750 watts, as the vestry may require. In passages, and other places where arc lamps are not required, incandescent lamps of 60 or 120 watts are to be fitted, to existing gas brackets where necessary. The work is to be begun immediately, and to be completed, so far as the 600 arc lamps are concerned, by June 30, 1902. The total cost of lighting the 42 miles of public ways contained in the parish is estimated at about £17,000 per annum, as compared with £11,000, the present cost of lighting with gas. For this additional expense the ratepayers will get from 15 to 20 times the amount of light which they enjoy at present. The agreement is to remain in force for 31 years, or until the undertaking is purchased by the local authority, whichever shall happen first. The annual cost of each lamp will be: 750 watts arc lamp, £32; 500 watts arc lamp, £22; 120 watts incandescent lamp, £4; 60 watts incandescent lamp, £3. These rates are to be subject to a cumulative rebate of ½ per cent per annum for each year after the first full year during which any lamp has been used.

THE ELECTRICAL POWER DISTRIBUTION COMPANY, LIMITED, is offering to the public a share capital of £300,000. As stated in its prospectus, this company was formed in 1898 with a nominal capital of £20,200, the whole of which has been paid up. In many of the industrial and other districts of the United Kingdom there is wide scope for the supply of electrical energy for lighting, tramways, light railways and other power purposes. Considerable economy can be effected in the generation of electricity by combining the supply for these various purposes, and an agreement has been made with the British Electric Traction Company, Limited, under which that company will, whenever possible, co-operate with this company and take electrical energy for its tramways and light railways from the power stations of this company. The operations of the company will comprise the construction and working of electric power distribution undertakings in various localities, the promotion and acquisition of powers for such undertakings, and the supply of electric energy in bulk to other authorized undertakers. These operations may be carried on by the company itself or by means of associated companies formed for the purpose. From these and other sources the directors believe that large profits will be realized. The directors of the company are as follows: J. S. Raworth, M.Inst.C.E., chairman, a director of the British Electric Traction Company, Limited, and of the Brush Electrical Engineering Company, Limited; Emile Garcke, M.I.E.E., managing director of the British Electric Traction Company, Limited; C. Shirreff Hilton, director of the British Electric Traction Company, Limited; R. Percy Sellon, M.I.E.E., general manager of the Brush Electrical Engineering Company, Limited, and William L. Madgen, M.I.E.E., managing director.

General News.

THE TELEPHONE.

ERIE, PA.—The Mutual Telephone Company of this city has just moved into a new building of its own. It has 1200 subscribers, its switchboard capacity being 1500 drops.

ALBANY, N. Y.—The Yorktown Telephone Company has been incorporated. Capital, $2,500. Directors: T. F. Tompkins, E. B. Kear, Yorktown Heights; C. W. Pugsley, Peekskill.

HARRISONVILLE, MO.—The Quick Telephone Company has been incorporated, with a capital of $20,000. The incorporators are: Shem. Zook, Maurice Quick, P. H. Wirt and others.

INDIANAPOLIS, IND.—The Central Indiana Telephone Company, of Sheridan, has been incorporated. Capital, $10,000. Incorporators: J. H. Cox, J. D. Cox, L. J. Cox, all of Sheridan.

MONDOVI, WIS.—The Wisconsin Telephone Company (Erie system) has just completed the installation of a new exchange at this place, with 65 subscribers connected to start with.

CHARLOTTE, N. C.—D. R. Crecy is promoting a telephone company to operate between Richmond, Norfolk and other cities. The capital stock, if the organization is perfected, will be $200,000.

CHARLESTON, S. C.—Cecil G. Fennell, of New York City, and others, propose to establish telephone lines between Charleston, S. C., and several neighboring islands. The capital stock will be $4,000.

PRAIRIE DEPOT, OHIO.—T. J. Maxell, half-owner of the local independent telephone exchange, has sold out his interest to C. F. Brant. George H. Reed retains his interest and will continue as manager.

CINCINNATI, OHIO.—The City & Suburban Telegraph Association has sent a communication to the board of education, in which it offers to put in a telephone in every public school building free of charge.

NEW YORK, N. Y.—Tests of practical value have been made recently by the Erie Railroad management looking, it is reported, to a superseding of telegraph messages by telephone service in the operation of trains.

MILWAUKEE, WIS.—The Wisconsin branch of the Erie Telephone Company on Nov. 26 increased its capital from $3,000,000 to $5,000,000. Half of the added capital will be expended at once on improvements in Milwaukee and the State.

ATLANTA, GA.—It is reported that the Southern Bell Telephone & Telegraph Company and the Cumberland Telephone Company, operated exclusively in the Southern States, are to be consolidated under a single management in the immediate future.

WINCHESTER, KY.—The Winchester Telephone Company is building 10 miles of country residence lines. Within the past year and a half the number of subscribers has increased from 110 to 270. Its board capacity is 300. Mr. J. W. Chambers is secretary.

EAST LIVERPOOL, OHIO.—The Columbiana County Telephone Company is preparing to install an exchange in Chester, W. Va., opposite this place. Wires will cross the Ohio River 120 ft. above the surface of the water by means of three poles, the centre one being on Babb's Island.

HAGERSTOWN, MD.—At a meeting of the stockholders of the Tristate Telephone Company the following officers were elected: President, Walter M. Widmyer; vice-presidents, George Mills and H. W. Disher; treasurer, Isaiah Lehman; secretary, John T. Mason; general manager, William P. Lashley.

CAMBRIDGE, MD.—The Diamond State Telephone Company is making preparations to rebuild the lines recently acquired by it in Dorchester County. The managers expect to run their line to Vienna and other points in upper Dorchester during the coming year and to extend it in lower Dorchester to Church Creek, Madison and Taylor's Island.

ALBANY, N. Y.—The Dutchess County Telephone Company, with principal offices at Poughkeepsie and a capital stock of $125,000, has been incorporated. The directors are: A. A. McGlashan, Myndert J. Van Kleeck, of New York City; H. A. Tucker, Asa Lippincott, of Brooklyn; George W. Sutton, John H. Scofield, Arthur E. Walradt, of New Rochelle.

ALLIANCE, OHIO.—A temporary injunction restraining the defendants from building a telephone system until the validity of the franchise ordinance has been settled has been granted against the Columbiana County Telephone Company and the United States Telephone Company. In order to facilitate matters, the defendants are preparing a new ordinance which will probably be granted by the Council, thus avoiding further delay.

AUSTIN, TEX.—The strike of the employees of the Southwestern Telephone Company has now spread to all the leading cities of the State. The exchanges and the long distance operators and linemen are out at San Antonio, Houston, Waco, Galveston, Dallas, Fort Worth, Temple and El Paso. The company is filling the places of the strikers with non-unionists as rapidly as possible. At San Antonio the long distance wires were recently cut.

ELECTRIC LIGHT AND POWER.

LINTON, IND.—A new electric light plant will be installed in this city soon.

SHELBY, N. C.—R. B. Miller and others will establish an electric light plant at this place.

SENECA FALLS, N. Y.—The Seneca Edison Company is laying the foundation for a new 200-hp engine for the new alternating dynamo.

ROCKVILLE, IND.—The new electric light plant erected for this city has been completed and awaits acceptance by the city authorities.

POMEROY, OHIO.—The population of this place is 5500. The town pays a private company $89 per street arc per year. Coal is 87 cents per ton.

FARMINGTON, MO.—Owing to a disagreement between the electric light company and the Town Board as to prices, the street lights have been shut off.

ROACHDALE, IND.—A company is being formed to put in a new electric light plant here. Albert F. Fields, a prominent citizen, is interested in the enterprise.

CLEVELAND, OHIO.—The Commissioners of Cuyahoga County are figuring on installing a lighting plant in the court houses and jail and Commissioner Asling is securing estimates.

BIRMINGHAM, ALA.—A meeting of the stockholders of the Birmingham Railway, Light & Power Company will be held on Dec. 28, to consider and vote upon a proposition that the company issue bonds to the amount of $3,500,000.

LONDON, OHIO.—This town has a population of 5000 inhabitants and furnishes its own electric lighting service at a cost of $57.58 per street arc per year, which charge includes 7½ per cent for interest and depreciation. The cost of coal is $1.81 per ton.

ST. LOUIS, MO.—The House of Delegates has passed a bill to provide for the installation of an electric plant at Chain of Rocks for the purpose of furnishing power to light the water works and water towers and to operate an electric railway from Humboldt Street to the Chain of Rocks.

ST. LOUIS, MO.—The Aerial Electric & Manufacturing Company has applied for a franchise to lay an underground system for electric wires in the county. It also asks the privilege of erecting poles and wires along the public highways. The object is to furnish electric power and light in the county.

ALTON, ILL.—At trustee's sale of the property and stock of the defunct Alton Electric & Service Company, a representative of the firm of Gaylord, Blessing & Company, of St. Louis, was the successful bidder at $5,200. An effort will be made by the purchasers to secure the contract for lighting the city.

SAN FRANCISCO, CALIF.—Fruitvale, a suburb of Oakland, is to have its own electric light and power plant in the near future. Articles of incorporation of the Fruitvale Light, Heat & Power Company have been filed. The capital stock is $100,000. The incorporators are Luke Battles, Amy G. Fehnemann, J. C. Hammell, A. N. Frost, J. H. W. Riley, P. H. Blake and B. Fehnemann.

MORRISBURG, ONT.—A considerable development of water-power is taking place along the canal at Morrisburg, Ont., where about $100,000 is being spent in hydraulic and electrical works. The former equipment is being supplied by the William Hamilton Manufacturing Company, of Peterboro, Ont., and the latter by the Canadian General Electric Company. The latter company is now installing a 200-kw, revolving field, three-phase generator, with transformers, etc. It is expected that power and light will be supplied to the district early in the new year.

THE ELECTRIC RAILWAY.

ELLWOOD, IND.—Henry F. Stillwell is heading a company to build an electric railway from this city to Indianapolis, via Tipton.

BURLINGHAM, ALA.—Application has been made by E. F. Enslen and associates to operate an electric railway here. A charter has not yet been issued.

CONNEAUT, OHIO.—The owners of the Pennsylvania & Ohio Railway Company will extend the road to Ashtabula. It is said to be the intention to build to Painesville.

SANDUSKY, OHIO.—The Sandusky, Norwalk & Southern Electric Railway Company has made a proposition to the owners of the White Line, in this city, for the consolidation of the two properties.

KENOSHA, WIS.—The Milwaukee Light, Heat & Traction Company has presented to the Common Council of this city another franchise asking for a right of way through the city for the Chicago-Milwaukee line.

COLUMBUS, OHIO.—The Franklin County Commissioners, a few days ago, declared forfeited the franchise granted to the Columbus & Lancaster Traction Company, because of failure to commence construction at the agreed-upon time.

MONTREAL, QUE.—The Montreal Electric Street Railway Company has introduced an innovation in street railway building in the reconstruction of its track on St. James Street in this city. Steel ties, to which the rails are firmly bolted, are used.

JEFFERSON, OHIO.—P. W. Tuttle, C. W. Goodrich and I. B. Read, of Ashtabula, have applied to the Ashtabula County Commissioners and the Council of this city for franchises for an electric railway from Geneva to Meadville, Pa., passing through Jefferson and Pierpont.

RENSSELAER, IND.—Indiana and Michigan capitalists have incorporated a company for the purpose of building an electric railway through Jasper, Newton, Pulaski, Fulton, Kosciusko, Whitley and Noble counties, the road to be known as the Chicago & Toledo Railway Company.

RACINE, WIS.—The Milwaukee Electric Railway & Light Company is making extensive improvements on its power house and system in this city. A new power house will be erected and the system enlarged and the entire installation will be based on a big future increase in the lighting business.

KENOSHA, WIS.—The opposition to the proposed railroad franchise for the Milwaukee Light, Heat & Traction Company is growing and business men are more in favor of a local line. The Haynes-Clausen franchise is regarded as the most liberal franchise for the city ever presented to the Council.

PITTSBURG, PA.—The Suburban Electric Railway Company, of Pittsburg, which recently succeeded in gaining access into the downtown part of Pittsburg by a traffic arrangement with the Consolidated Traction Company, is contemplating the expenditure of about $100,000 in the improvement of its property.

MILWAUKEE, WIS.—In about two weeks the directors of the Milwaukee Electric Railway & Light Company will meet in New York. At this meeting action will be taken on the $10,000,000 improvements asked by the company. If allowed the expenditure will be at the rate of about $2,000,000 per year for five years.

YOUNGSTOWN, OHIO.—The new Lowellville line of the Mahoning Valley Electric Railway Company was opened a few days ago. President Anderson and the officials of the road gave a trolley party, which was participated in by invited guests. In the future there will be a 30-minute through service from Niles to Lowellville.

FINDLAY, OHIO.—The Dover Construction Company, of Canal Dover, which is building the Toledo, Fostoria & Findlay Electric Railway, has sublet contracts for masonry work and construction of power house to J. B. Wells, of Findlay. Bids for the equipment of the power house have been called for and contracts will be closed in the near future.

BUFFALO, N. Y.—A strong Morgan influence developed at the annual election of the Buffalo Railway Company on Nov. 24. Robert Bacon and Charles Steele, of J. P. Morgan & Company, were elected directors, as also were Francis Lynde Stetson, counsel to Mr. Morgan, and Col. Daniel S. Lamont, first vice-president of the Northern Pacific Railroad, which is controlled by J. Pierpont Morgan.

LEGAL.

NEW ORLEANS TELEPHONE RATES SUSTAINED.—A decision has been rendered by the State railroad commission in the suit of the New Orleans (La.) Board of Trade vs. the Cumberland Telephone Company, controlling the system in use at New Orleans. The decision sustains the present charges, thus upholding the company's rates for telephones.

MUNICIPAL LIGHTING PLANT.—Judge Taylor, in Frankfort, Ind., has decided the case of Hines against the city of Frankfort, in which the plaintiff sought to enjoin the city from purchasing an electric light plant, on the ground that the purchase would exceed the constitutional 2 per cent indebtedness. The court held that the contract between the city and the Erie Iron Works was a lease, not a purchase, hence the city cannot escape payment on the ground of exceeding constitutional limitation for a city's debt.

LEGISLATION IN INDIANA.—Under the guise of an anti-trust bill, a measure will be introduced in the Indiana Legislature, providing against any agreement or arrangement of corporations which may tend to lessen full and free competition, or against any corporation selling, transferring, leasing or in any other way parting with the control of its property or franchise to a competing company for the purpose of destroying competition. The penalty provided is forfeiture of franchise. A bill to regulate telegraph tolls and telephone tolls will be introduced. Also a bill requiring telephone companies to connect with other lines. This measure is being prepared, it is said, by the competitors of the Central Telephone Company.

THE CARBORUNDUM COMPANY, of Niagara Falls, has gained a victory in its litigation with the Cowles Company. It will be recalled that recently the higher courts decided that the carborundum process infringed one of the Cowles patents, and following this decision the Cowles Company applied before the United States Circuit Court for the Western Division of Pennsylvania for an injunction to close the carborundum works at Niagara Falls. When this application was made, Judge Joseph Buffington was on the bench, and he not only refused the application, but also made some very positive statements on the subject. In refusing the injunction it was provided that the defendant company file a bond, the amount to be determined by the court, to secure damages to the complainant. Although Judge Buffington ordered an accounting made, he also said: "To grant an injunction would mean the stopping of the manufacture of carborundum and result most likely in serious damage to the defendant company, the sole makers of carborundum. The defendant cannot make carborundum without infringing a Cowles patent, and the plaintiff cannot make carborundum as the defendant has the exclusive rights. An injunction would do the complainant no good, but would take away the only means by which he can get damages."

PERSONAL.

MR. GEORGE BULLOCK, of the Bullock Electric Manufacturing Company, Cincinnati, Ohio, was in New York during the present week.

MR. DUNCAN McDONALD, superintendent of the Montreal Street Railway, has been appointed general manager of the Compagnie Metropolitan of Paris, France.

MR. LUDWIG GUTMANN informs us that he has severed his connection with the Royal Electric Company, with the intention of doing general engineering work and also of bringing out some of his inventions.

MR. T. D. LOCKWOOD, of the American Bell Telephone Company, was a visitor to New York last week and participated in the meeting of the American Institute of Electrical Engineers. His professional engagements do not allow him many opportunities for such excursions.

MR. G. G. WARD, vice-president and general manager of the Commercial Cable Company, has just returned from Germany, having completed his work there in connection with laying the United States-German cable. He has been decorated by Emperor William for his services to the empire.

MISS ELIZABETH FLEISCHMAN, who is recognized as the foremost radiographer of the Pacific Coast, was recently married to I. J. Aschheim. Her friends in this country and in Europe will be glad to learn that she will not be lost to radiography, but will continue her work in San Francisco. Miss Fleischman was made a member of the Röntgen Society of America on the merits of her work, and has been honored with a place on the committee on necrology.

SIGNAL CORPS PROMOTIONS.—The following promotions have been made in the First New York Signal Corps: Sergeant Godet, to First Sergeant; Corporals Baldwin and Maxwell, to Sergeants; Lance Corporal Scully, to Corporal, and Privates Caswell and Carney, to Corporals. Signal Sergt. George McKibbin, of Squadron A, N. G. N. Y., has been attending the drills of the First Signal Corps, in order to perfect himself in signaling, previous to undertaking the instruction of a signal squad in Squadron A. Lieut. Henry W. Sprague, N. G. M., has also been an interested visitor, his object being to gather information upon which to model the signal service in Massachusetts.

MR. A. M. MATTICE has been appointed chief engineer of the Westinghouse Electric & Manufacturing Company. Mr. Mattice was for some years chief assistant to Mr. E. D. Leavitt, of Cambridgeport, Mass., consulting engineer of the Calumet and Hecla copper mines and famous as the designer of pumping and other machinery. A former engineer officer of the navy, Mr. Mattice graduated from the Naval Academy at the head of the class of 1874, of which class Mr. B. H. Warren, vice-president of the Westinghouse Company, was also a member. During a considerable period he acted as assistant to the Engineer-in-Chief of the Navy, and just previous to resigning from the service had direct charge of designing the machinery of the Maine and Monadnock and that of the first swift cruisers. In fact, the work of Mr. Mattice as a marine designer largely fixed the types of naval machinery which have placed our war vessels on their present high plane of efficiency. Since leaving the naval service he has had much contact with electrical work in his engineering practice, particularly with

reference to the application of electricity to power purposes, for the study of which application he made a visit to Europe some years ago when that branch had scarcely reached an initiatory stage in this country. Upon his return the extensive electric power plants of the Michigan copper mines were commenced, which plants for some years were among the few large applications of electric power in this country. Mr. Mattice is generally considered by competent judges, who know his work and ability, as the ablest of the younger engineers of to-day; indeed, Admiral Melville, whose principal assistant he was for some years, has never ceased to say that he considers him the ablest engineer he has ever known. Personally, Mr. Mattice is a most agreeable gentleman, deservedly popular with all who know him. While a great student he is not a "bookish" man, but a broad and liberal man of affairs. Mr. Westinghouse has shown repeatedly in his selection of his chief assistants the same shrewd judgment that has contributed so largely to his success as an inventor and business man. Himself a man of brains and great capacity for work, he likes to surround himself with others of the same stamp, and in securing the services of Mr. Mattice he has given a special example of his discernment.

EDUCATIONAL.

UNIVERSITY OF MICHIGAN.—A 3-kw rotary converter has been added to the equipment of the electrical laboratory of the University of Michigan. The machine was manufactured by the Fort Wayne Electric Works. Prof. H. S. Carhart, of the university, is the author of an article in the July issue of the *Physical Review*, entitled Thermodynamics of the Voltaic Cell. The article embodies the results of the investigations conducted by Professor Carhart last year while in Zurich, Switzerland. Dr. Karl E. Guthe, of the department of physics of the University of Michigan, is spending the present year in Leipsic, Germany, conducting investigations in the general subject of physical chemistry.

MR. E. C. OLIVER, of the Mechanical Engineering Department of the University of Illinois, has just succeeded in perfecting an automatic recording machine which is not only a credit to the College of Engineering, but to the University as well. For several years Mr. Oliver has been at work under the advice of Professor Breckenridge on a machine which would record automatically different lines of data with regard to the speed and power of engines. He has at last designed and constructed this universal recorder, which can be applied to either gas or steam engine or to a dynamometer car, and which is capable of taking any one or all of eight readings by means of ink tubes passed over an endless roll of paper. The ink tubes are attached to the armatures of electromagnets and these magnets are electrically connected with the different parts of the engine to be tested and are actuated by the electric current. The recorder gives faithfully the speed of the engine, the number of the horse-power exerted, the rate of the occurrence of the explosions and the number of revolutions per minute of a gas engine. The machine is very carefully worked out and should prove of great value in experimental as well as practical work.

Trade Notes.

THE AMERICAN BRIDGE COMPANY is furnishing from its Lafayette plant five bridges for Montgomery County, Ind.

THE AMERICAN SHEET STEEL COMPANY, of New York, has ordered at different times 11 Cross oil filters from the Burt Manufacturing Company, Akron, Ohio.

THE ELECTRIC APPLIANCE COMPANY, Chicago, wishes to state in answer to numerous inquiries that the Gutmann wattmeter is not made at present for direct current. The type it is selling is for alternating current only.

THE LUNKENHEIMER COMPANY, Cincinnati, Ohio, is installing a complete electric plant in its new machine shop and factory. It is possible that a portion of this plant will be utilized in building automobiles.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, has closed several contracts recently, among which is one for two 800-kw generators for a tramway in Alexandria, Egypt, and three 200-kw railway generators to go to Philadelphia.

MR. G. B. PRATT, of Gowanda, N. Y., Eastern representative of the Eureka Electric Company, is distributing this season two handsome calendars—one with Corot's "Dance of the Nymphs," and the other the "Cupids Making a Fire." He will be glad to mail one of these to anyone interested in telephonic apparatus.

POWER HOUSE EQUIPMENT.—The Westinghouse Electric & Manufacturing Company, through its Cincinnati office, has closed a contract with the Dayton & Troy Electric Railway Company for a new generating station, to be located at Tippecanoe, Ohio. Sargent & Lundy, of Chicago, are consulting engineers for the company.

POWER PRESSES.—Bliss inclinable power presses are illustrated and briefly described as to their principal features in a 16-page pamphlet just issued by the E. W. Bliss Company, Brooklyn Borough, New York. Ten different styles of presses are very clearly illustrated, and on the back cover is given a view of the erecting shops of the company.

MAGNETIC BRAKE COMPANY.—Messrs. W. T. Pember, G. H. B. Hooper and W. D. Earngey, of Toronto, Ont., have been incorporated as the Magnetic Electric Brake Company by the Ontario Government, to manufacture, sell and deal in magnetic-electric brakes. The capital of the new company is $500,000, and its head office is in Toronto.

THE JANTZ & LEIST ELECTRIC COMPANY, Cincinnati, reports now enjoying the best business in the history of the establishment. It has added new tools of every description to its plant, until it is now so crowded that the firm is looking for new and larger quarters. The principal call is for machinery for power and light in isolated plants.

DISSOLUTION AND REORGANIZATION.—The firm of Naugle, Holcomb & Company, Chicago, Ill., on Nov. 12, was dissolved by mutual consent. The business of the firm is continued by the Naugle-Holcomb Company, organized in Illinois for the purpose. The company manufactures and deals in oak and cedar railway ties, telegraph poles, posts, etc.

LARGE FOUNDRY.—The Buckeye Engine Company, Salem, Ohio, recently placed contracts for what will be one of the largest and most complete foundries in Ohio. The building will be of steel, 203 ft. x 80 ft., and will be built by the Fort Pitt Bridge Works, Pittsburg. Its equipment will include two electric traveling cranes of 15 tons and 25 tons capacity.

THE GREGORY ELECTRIC COMPANY, Chicago, has received at its works all of the dynamos, motors, testing instruments and supplies recently acquired from the Siemens & Halske Electric Company; also all of the Gibbs machines, all of which were recently purchased by the Gregory Company. All of these are listed in monthly bargain sheets which are now being sent out.

NEW YORK CENTRAL MILEAGE.—The mileage of the New York Central & Hudson River Railroad Company has been increased by the lease of the Boston & Albany Railroad. Hereafter the 1000-mile tickets of the New York Central will be good on the Boston & Albany line. This gives the holder of such tickets the privilege of riding over lines aggregating more than 6000 miles.

DYNAMO FIELD RHEOSTATS.—The Cutler-Hammer Manufacturing Company, Milwaukee, Wis., informs us that there is a very large demand for its enclosed type of dynamo field rheostats. These rheostats are guaranteed not to burn out. They are very compact, ornamental and give close regulation to the dynamo. Those interested are invited to communicate with the company.

THE LAWTON BEATTIE ELECTRIC COMPANY, Cincinnati, is installing a complete telephone system in the new plant of the American Rolling Mill Company, at Middletown, Ohio. The Lawton Beattie Company is also putting in an alternating system for street and public lighting at Spencerville, Ohio. The equipment is being furnished by the Fort Wayne Electric Works, Fort Wayne, Ind.

REMOVAL.—The business of H. M. Shaw & Company, New York, has grown to such proportions that it has been found necessary to remove their factory from Rahway, N. J., to Newark, N. J., in order to take advantage of unlimited manufacturing and shipping facilities. The firm's executive offices have been located at 115 Broadway, New York, thus enabling it to keep in close touch with the trade.

RIKER AUTOMOBILES.—A very handsomely illustrated catalogue has been issued by the Riker Motor Vehicle Company, of Elizabethport, N. J. It contains excellent views of the different classes of electrical vehicles manufactured by this company, many of which have from time to time been illustrated in these columns. The principal features of the different vehicles are described in connection with the illustrations.

STEEL PLATE FANS.—The subject of fans for ventilation and air supply is an interesting one. The B. F. Sturtevant Company, Boston, Mass., has issued a very complete catalogue on the subject of steel plate fans, a long line of which it manufactures. The various styles of fans are illustrated and the description of each is accompanied by tables showing dimensions, speed, etc. The catalogue contains 132 pages and covers the subject very thoroughly. It includes several tables that are helpful in engineering calculations.

J. J. REIDY, of New Haven, Conn., maker of the Donnelly improved steel climbers, has arranged with the following concerns in New York City to carry a stock and supply the smaller trades at lowest factory prices: J. H. Bunnell & Company, the J. Jones & Son Company, Manhattan Electrical Supply Company, Manufacturers & Inventors' Electric Company, Morris Electric Company, Stanley & Patterson and the Western Electric Company.

POCKET INSTRUMENTS.—The voltmeters and ammeters manufactured by L. M. Pignolet, 78 Cortlandt St., New York, have met with a warm reception. It is less than three months ago that they were first introduced, and to-day the number of duplicate orders received indicates that the instruments have been tested in actual work and found to be not mere playthings, but of practical worth. The instruments have a nickel-plate finish, are direct reading and pocket size.

MORRIS E. LEEDS & COMPANY, of Philadelphia, who have manufactured the "Jagabi" portable testing set for about one year and a half past, have improved the apparatus in certain important respects, and to emphasize this fact it has been decided to change the name to the "Leeds Portable Testing Set." A very comprehensive pamphlet (No. 340) has just been issued to describe the new apparatus, and to tell how to use it. Every one interested in Wheatstone bridge measurements should write for a copy to James G. Biddle, 1024 Stephen Girard Building, Philadelphia, who is sole agent for all apparatus manufactured by the concern.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, has booked several orders recently, including the following: One 50-kw belted machine for Thief River Falls, Minn., to be used in a city plant; several motors to drive various machines in the factory of A. I. Root & Company, Medina, Ohio, and a complete electric plant for the Cole Investment Company, St. Louis, consisting of two 75-kw direct connected generators; also a plant for the Buxton & Skinner Stationery Company, St. Louis, Mo., including two 50-kw direct connected generators and a belted type generator for the Fleischman Company for use at the Riverside Distillery.

THE *LIVING AGE* FOR 1901.—During the 57 years of its existence this sterling weekly magazine has steadily maintained its high standard. It is a thoroughly satisfactory compilation of the most valuable literature of the day, and as such is unrivalled. As periodicals of all sorts continue to multiply, this maga zine continues to increase in value. By its aid the reader can, with an economy of time, labor and money, keep well abreast with the literary and scientific progress of the age, and with the work of the ablest living writers. It is the most comprehensive of magazines, and its prospectus for 1901 is well worth the attention of all who are selecting their reading matter for the new year. The Living Age Company, Boston, is the publisher. Its offer to new subscribers is particularly inviting.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has just issued bulletin No. 3025, which describes a reliable and low-priced

alternating-current motor in sizes from 1/10 to ⅙ actual horse-power. This type of motor is made with ½ in. shaft and is suitable for severe and continuous operation, being a much more durable motor than many types of similar capacity now on the market. A copy of bulletin No. 3025 will be sent free to any address on request, and a sample of this new type of motor will be forwarded to any responsible electrical dealer or central station interested.

AMBITIOUS MECHANICS, who desire to obtain better positions and higher wages, might do worse than investigate the Free Scholarship offer made by the American School of Correspondence, Boston, Mass. Situated in a large city which is a recognized educational and industrial centre, this school has many advantages in teaching the theory of the trades and engineering professions. Without leaving home or losing time from work, the student pursues a thorough course of study under the direction of able instructors, who are always ready and willing to assist him. Instruction papers, prepared especially for teaching by mail, are furnished free. These papers are written in clear and concise language, as free as possible from technicalities. In addition, special information regarding any difficulties in their studies, is furnished students without extra charge. It should be the ambition of every man to advance in his trade or profession. A mechanic with practical experience, supplemented by theoretical education, can command a better position than a man without such an education. The result of long experience in teaching by mail shows that the method meets the requirements of men who have but little time for study.

Record of Electrical Patents.

UNITED STATES PATENTS, ISSUED NOV. 20, 1900.

[Conducted by William A. Rosenbaum, Patent Attorney, Times Bldg., N. Y.]

661,971. CONTROL OF ELECTRIC MOTORS; F. W. Garrett, Johnstown, Pa. App. filed March 26, 1900. The invention consists in a method of series-parallel control applied to a plurality of motors operated in groups, preferably pairs, in which certain of the intermediate circuit changes or steps are effected in one group of motors before the similar changes or steps are effected in the other group or groups, the circuit in one group or groups remaining unbroken, while that of the other group is opened to effect the desired changes. In this manner some of the motors are at all times during the change from series to parallel acting to propel the car.

661,972. CONTROLLER FOR ELECTRIC MOTORS; F. W. Garrett, Johnstown, Pa. App. filed March 26, 1900. A modification of the preceding.

661,975. TROLLEY; H. S. Goughnour, Johnstown, Pa. App. filed Dec. 12, 1899. For carrying the current from the wheel to the pole without excessive wear; the ends of the axle are confined between two springs attached to the hub.

661,986. SUPPORTING BLOCK OR BRACKET FOR ELECTRIC FIXTURES; J. W. Heizer, Chicago, Ill. App. filed Dec. 30, 1899. A base with a dove-tailed groove is fixed to the wall and a corresponding part is fixed to the lamp, the two parts being readily adjusted to each other.

661,988. TELEPHONE RECEIVER; H. H. Hipwell, Allegany, Pa. App. filed Feb. 10, 1900. The pole of the magnet is adjustable towards and away from the diaphragm.

662,003. WASHER; A. Lamm, Berlin, Germany. App. filed June 9, 1900. A metallic washer having projections on it which is to be inserted between the meeting surfaces of a joint in an electrical conductor such as a rail bond.

662,048. ELECTRIC ARC LAMP; J. J. Wood, Fort Wayne, Ind. App. filed July 28, 1898. Details.

662,049. AUTOMATIC CIRCUIT BREAKING APPARATUS; G. T. Woods, Monsey, N. Y. App. filed Aug. 24, 1898. In a sectional railway system an automatic device is carried by the car which interferes with the work of the car motor when a preceding section switch fails to break the corresponding circuit.

662,110. TRANSLATING DEVICE; F. M. Bell, New York. App. filed Dec. 19, 1898. This is a novel form of connecting plug.

662,156. PROCESS OF GAUGING HIGH VACUUMS; J. Waring, Hartford, Conn. App. filed June 4, 1900. (See Current News and Notes.)

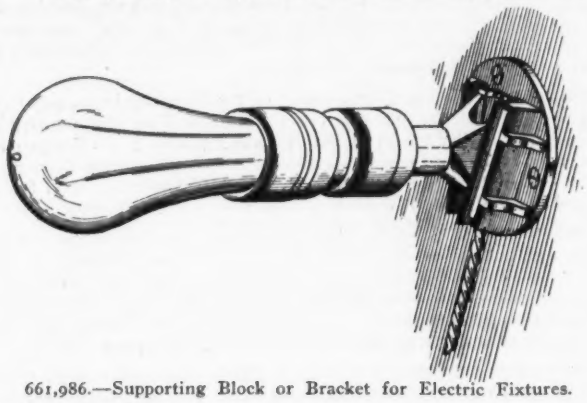
662,218. ELECTRIC CAR SIGN; I. B. Brower, Philadelphia, Pa. App. filed Nov. 15, 1899. The circuit for the lamps in the sign passes through the brackets which sustain the sign.

662,223. MEDICINAL BOOT OR SHOE; H. F. Crawford, Brockton, Mass. App. filed July 9, 1900. A recess in the heel of the shoe contains a battery.

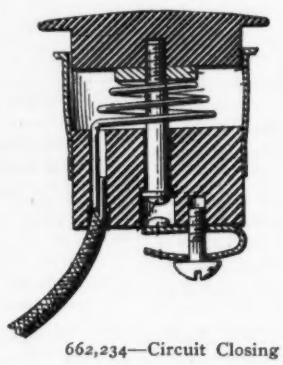
662,234. CIRCUIT CLOSING DEVICE; E. W. Hazazer, New York. App. filed Oct. 7, 1899. A push button constructed to occupy a small space, being at the same time cheap and durable.

662,244. POLE TOP; P. G. Reynolds, Detroit, Mich. App. filed Aug. 20, 1900. This is a spider frame placed on top of a pole to sustain the insulators and properly direct and insulate the wires.

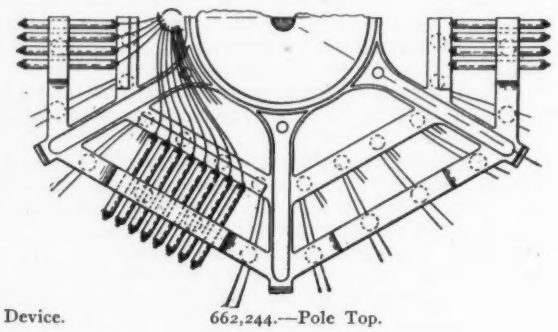
662,277. SEPARATOR FOR SECONDARY BATTERY PLATES; H. Leitner. London, England. App. filed May 28, 1900. The separator consists of two sheets of non-conducting material having holes and ribs, and cemented together.



661,986.—Supporting Block or Bracket for Electric Fixtures.



662,234—Circuit Closing Device.



662,244.—Pole Top.

662,009. TROLLEY; F. A. Merrick, Johnstown, Pa. App. filed Jan. 18, 1900. A spring-pressed contact device is secured to the wheel and engages the spindle through the hub of the wheel.

662,010. SPACE-BLOCK FOR ARMATURE CORES; E. W. Mix and F. G. H. Faure, Paris, France. App. filed Oct. 11, 1899. The space-block is made of sheet metal held edgewise between the armature sections.

662,020. MEANS FOR RAPIDLY TRANSMITTING TELEGRAMS; A. Pollak and J. Virag, Buda-Pesth, Austria-Hungary. App. filed May 9, 1899. The transmitter sends impulses which affect the receiver for a duration corresponding to its period of oscillation, thereby suppressing supplementary oscillations.

662,021. METHOD OF RAPIDLY TRANSMITTING TELEGRAMS; A. Pollak and J. Virag, Buda-Pesth, Austria-Hungary. App. filed Dec. 21, 1899. A modification of the preceding.

662,032. AUTOMATIC FIRE ALARM DEVICE; E. F. Sitts, Herkimer, N. Y. App. filed July 10, 1899. Two contact springs are held apart by a plug of fusible material.

662,038. CONTROLLER; E. W. Stull, Johnstown, Pa. App. filed Dec. 28, 1899. A device automatically actuated to lock the controller against forward movement whenever the current in the motor circuit exceeds a certain predetermined volume.

662,039. CONTROL OF ELECTRIC MOTORS; E. W. Stull, Johnstown, Pa. App. filed June 8, 1900. For controlling four or more motors by connecting them in various series and parallel relations.

662,042. DYNAMO ELECTRIC MACHINE; F. W. Throop, Niagara Falls, N. Y. App. filed Jan. 29, 1900. The current is generated in a machine of the same principle as Faraday's disk.

662,278. AURAL BATTERY; C. W. Levalley, Milwaukee, Wis. App. filed July 17, 1900. A tubular device composed of the elements of a battery and intended to be worn in the ear without interfering with the sense of hearing.

662,286. ELECTROLYTIC APPARATUS; E. Motz, Jefferson, S. C. App. filed May 26, 1900. The ore, after being crushed and mixed with a solvent in solution, is subjected to the action of an electric current and to agitation, whereby the larger particles of precious metal are deposited and amalgamated at once and the complete solution and deposition of the smaller particles are effected rapidly and at small cost.

662,308. MESSAGE RECORDING INSTRUMENT; J. J. Ruddick, Newton, Mass. App. filed Aug. 7, 1899. The main feature of the invention is a separate frame or support for each marking roll, which is pivoted to an independently detachable arm and elastically connected to the armature of an electromagnet.

662,316. MAGNETO ELECTRIC MACHINE; F. R. Simms, London, England. App. filed July 5, 1900. A continuously rotating segmental envelope is interposed between the stationary armature and the magnets.

662,358. CONTROLLER FOR MOTORS AND BRAKES FOR ELECTRIC CARS; A. Grossman, New Orleans, La. App. filed July 5, 1900. An improvement on the mechanism described in U. S. patent No. 594,946.

662,369. TERMINAL CONNECTION FOR ELECTRIC LAMPS; A. J. Wurts, Pittsburg, Pa. App. filed Jan. 27, 1900. (See Current News and Notes.)

662,375. MULTIPLE VOLTAGE CONTROLLER; G. S. Dunn, East Orange, N. J. App. filed March 21, 1900. (See Current News and Notes.)

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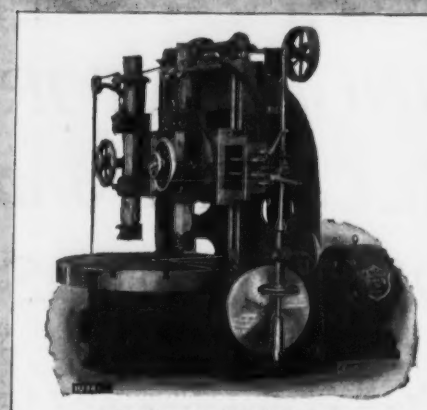

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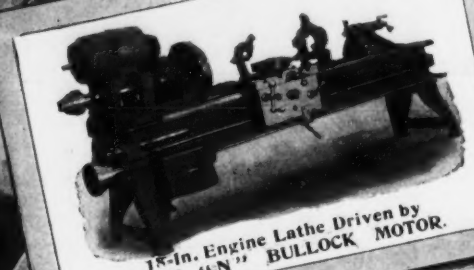
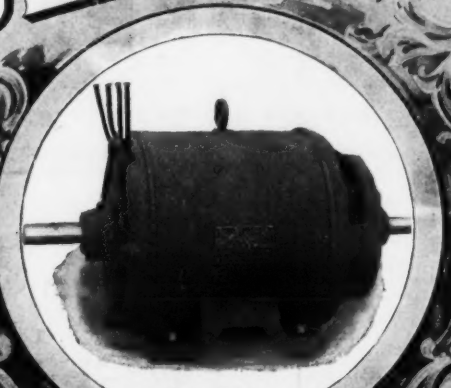


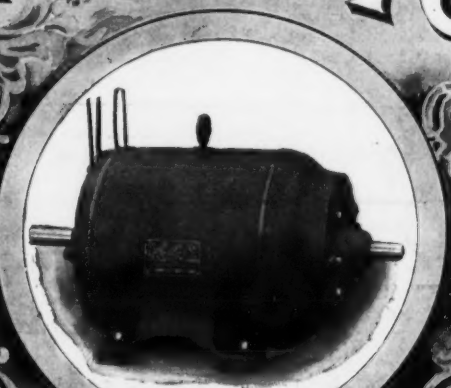
18-In. Engine Lathe Driven by TYPE "N" BULLOCK MOTOR.

20-In. Engine Lathe Driven by TYPE "N" BULLOCK MOTOR.

TYPE BULLOCK "N" MOTOR



Open Ends.



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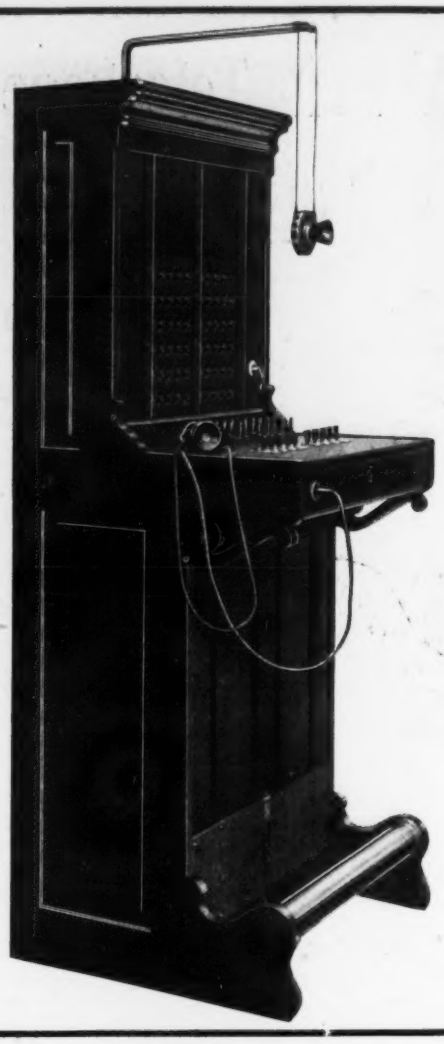
This company owns Letters Patent No. 463,569, granted to Emile Berliner November 17, 1891, for a combined telegraph and telephone, covering all forms of microphone transmitters or contact telephones.



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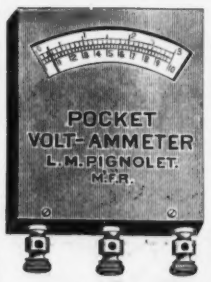

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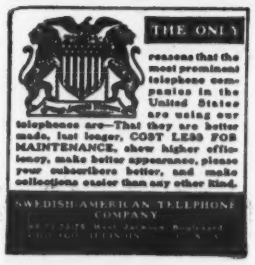
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